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HOW SHALL A CITY BE INVESTIGATED

The Nashville muddle shows what can be done in interfering with municipal business and increasing cost of doing it when investigations are started to serve personal ends or vent personal spite. It is undoubtedly true that the city government of Nashville is inefficient and possibly to some extent dishonest, but so are the governments of all cities and of all great corporations of any sort, whether public or private, it is only a question of degree. But that is no reason for tying up the functions of government and causing expense and delay wholly unnecessary and yet inevitable under such circumstances.

It is a good thing to investigate a city government once in a while, whether it seems to be efficient or not, but let us do it in the right way and not block the wheels of progress while the job is being done.

After all, publicity is the best corrective of wrong conditions and a turning of the light upon the doings of the city officers will accomplish far more, in less time, with less interference with real business, and at less expense than the knock-down-and-drag-out methods under which Nashville has been suffering for the last year or more. And to what end? Some new men are in office but the routine of regular business is being resumed and one outside the city can see but little real result of a permanent nature.

MOTOR TRUCK HIGHWAYS

The passage of the bill providing for the expenditure of $85,000,000 by the United States Government in the construction of highways in the various states means the expenditure of several times that amount upon the same roads, as well as of still greater amounts upon their extension and the building of branch and connecting roads. At least twice the amount must be spent, as the government will not pay more than half the cost of the road and will not pay more than a fixed maximum per mile. Moreover, the cost of roads on which the government money is to be expended is fixed so high that a really good road is insured.

Such roads as will thus be made possible are no better than are necessary to carry the traffic of the future. The war has demonstrated the ability of the motor truck, under very trying conditions, and it is now necessary only to demonstrate its economy to insure its universal use.

One very important source of economy in motor truck haulage is the good road. Without it we know the truck can be made to go, but we also know that accidents are numerous, that the trucks must be helped out of bad places, that temporary reconstructions of roads or bridges are expensive; and so only the more adventurous are willing to try the experiment of running trucks regularly over the average roads of the present days, and they stop running when the roads become too soft to go over safely.

No one has yet been able to compute what the saving in truck transportation may be because no one can foresee what its development will be when we really have the good roads. We have been able to compute the saving to the farmer in getting his produce to market by horse transportation over 365-day roads, but that is only one step in the process. Farming will be revolutionized. The nature of the products to be brought to market will be changed, especially in the vicinity of the larger cities. Crops can be raised and successfully distributed which are impossible with present methods of transportation.

Study the developments of farming and of transportation in the vicinity of such cities as New York, Philadelphia, Boston, as the roads have been improved, and you will get some faint idea of what will happen around every city when the roads are sufficiently improved. The developments about many other cities are less only because the proportion of roads improved to the highest efficiency is less.

Interstate traffic with motor trucks may never be as great as with lighter automobile vehicles, but there will be plenty of it to justify the expenditure of the common funds in aiding the construction of state roads on lines approved by the National Government.

CIVIC SANITATION

Civic sanitation, including in that term the physical, mental and moral sanitation of the citizens, whether of city, town or country, is strongly emphasized on all sides just now; from the theoretical side in many such books as Prof. Herman G. James's "Handbook of Civic Improvement"; from the practical side by the many campaigns against various forms of disease, censorship of amusements, white slavery, and the like; from the commercial side in the exploitation of preparations for destroying or preventing disease germs, in societies to improve the mental and moral education of children, with the sale of books as the primary object, and others too numerous to mention.

The movement is one of the utmost importance and great good will undoubtedly result from the sum of all the efforts put forth, tho occasionally one is misguided and results in disaster.

Professor James's book is an excellent little guide to municipal studies along the lines of public health, safety, education and morals and the lists of questions on each subject, which he gives with each chapter, if answered for each city, will necessitate a thoro welfare survey of such city and the information thus obtained will form an excellent basis for plans for civic betterment.

The Municipal Supply Department IV.

AUDIT AND INSPECTION

By Hugh M. Foster, New York City.

The inspection of municipal supplies must be in honest hands or must be so checked that any departures from exact honestly can be discovered. How to do this without excessive expense is a problem. Auditing of the accounts of supplies purchased and issued is another check upon inspectors. Systems of handling these problems are worked out in this article.

(a) *Personal or Visual.*

THE function of audit in the case of supplies and the certification of claims for supplies is in its last analysis based on inspection. This power should be in an official independent of the purchasing agent and of the storekeeper. Within the department it should be exercised by the auditor of the department, and for the general function thruout all departments of the city should be exercised by the general auditor or comptroller or chief financial officer of the city. By expeditious auditing cash discounts are availed of, and a further advantage is gained for the city by promptness in payment of bills, as this attracts a larger and better class of dealers. The mistake has been made in the Cedar Rapids purchasing system of making the purchasing agent the auditor, and thereby he audits and checks himself, which is obviously unsound practice. As a wholesome check on the purchasing agent and storekeeper the inspection should remain in the hands of the auditor and the comptroller. The mere certificates of the subsidiary departments and the storekeeper and the purchasing agent are insufficient for the purpose of inspection and audit.

The comptroller in certifying claims should base such certification on the actual knowledge of his own subordinates, both auditors and inspectors. A subordinate auditor of accounts certifies to the propriety of all previous certifications, general signatures and appropriations. His certification as to quantity and quality is based on the actual physical inspection. Inspectors should be required to attach cards, tags or stamps to the goods which they inspect and pass, giving their name and date, and stating clearly that the goods have been so inspected and passed. To be effective inspection should be complete—that is, it should include all deliveries and a reasonable proportion of every delivery. The approval of the departments is not sufficient, as they are necessarily prejudiced by their likes and dislikes in actual use. Any complaints from them, however, should be given due consideration. Brands of goods are not sufficiently reliable or uniform to warrant the elimination of inspection.

Any competent and experienced inspector knows that regular monthly or weekly deliveries of a given article vary from week to week or month to month, and that one inspection of one delivery is no guide whatever as to the next delivery. The contention that the departments using supplies know their own needs and the qualities required is directly contradicted by good inspectional practice. The departments using supplies may know what they want, but their desires may be, and often are, unreasonable. The contention that after one inspection subsequent deliveries should be judged merely by brands of goods, would lead to all sorts of fraud. A good delivery of canned goods marked with a certain brand is no guarantee whatever that the next delivery of the same goods, under the same brand, will be of uniform quality. Variations are too well known to admit of much discussion on this point. A few actual inspections of such goods would demonstrate this error. The practice of having departmental inspections as well as inspections by the comptroller is not only a mere duplication of work, but frequently creates unnecessary friction. There should be one centralized and expert corps of inspectors.

In the city of New York 50,000 vouchers per annum are passed for supplies, at an average cost for clerical work in auditing and inspecting of $1.35 each. This does not represent all the work for each voucher, because each voucher may have attached to it many orders and bills. The obvious saving in clerical work alone would be enormous if a competent centralized supply department were established, by greatly reducing the number of individual purchase transactions. A further and almost equal saving could be achieved in inspection by the central concentration of deliveries at one general storehouse.

Specialization is an absolute desideratum in inspection. At present the Greater City of New York is divided into 18 districts, covering over 2,100 receiving points. These delivery points include schools, fire houses, police stations, street cleaning stables, section houses, almshouses, hospitals, and other large receiving points. To each of these districts an inspector is assigned and is required to inspect all the supplies delivered in that district, except such supplies as meat and lumber. To these items two inspectors devote their energies as specialists. It would seem that in the present development of commercial activity and even professional activity, the advantages of specialization hardly needed an advocate. No one man can readily know all the supplies delivered in a given district of the city. A man who possesses such knowledge would be worth far more in commercial life than in the small paid position as a city inspector. The value of an inspector of supplies depends, aside from the qualification of honesty, which is taken for granted, upon the inspector's knowledge of supplies. It stands to reason that any man must know one line, with its allied branches, better than he can know two.

The argument against specialization is the opportunity for bribery, aside from mere morality or from the question of business expediency in the loss by a wage-earner of his greatest asset, namely, his reputation. The opportunity for bribery is no more pronounced in specialization than in the district system. A man who is looking for a bribe will get it, no matter what restrictions are put on him, and the sooner he is discovered and eliminated the better for the system. The re-inspection of supplies by the chief or supervising inspector, from time to time, should keep track of such possibility.

The inspection of repairs should be separated from that of supplies, and men trained in repair work assigned to one branch, and men trained in supplies to the other. Repairs should be subdivided into painting, papering, decorating, carpentry and masonry, plumbing, roofing, steam and gas-fitting, and electrical work, and supplies therefor. Supplies should be subdivided into foods, forage, furniture, lumber and textiles. In large contracts of bulky supplies, such as iron, steel or materials of construction, it is frequently an advantage to make the inspection at the sources of supplies. It is better policy to prevent an error than to correct it after it has happened, and this practice is a saving of time and labor to the contractor

and to the city. I have in mind an instance of the kind in the case of a new hospital being equipped with hospital furniture. The specifications of the contract described elaborately the process of coating the iron frames with paint and enamel, and the number of coats to be applied, and described the character and dimensions of the metal. The inspection of this furniture was made after delivery at the hospital and there was no way for the inspector to know that the specifications had been complied with. The only way to arrive at such knowledge would be for the inspector to be on hand at the place of manufacture and watch the processes as the goods were made.

Proper supervision is an essential to good inspection. The chief of the inspection corps should not only review all reports, but should make frequent, irregular and unannounced visits in the field to watch inspectors at their work, to correct errors and to promote uniformity of inspection. It is a distinct loss to the city if goods are rejected at one point and accepted at another because of the variation in the competency of the inspectors. Contractors soon learn such a condition and take advantage of it to defraud the city. Proper inspection includes certification of quantities. For this purpose, at delivery points so large that actual physical count cannot be made by inspectors, the inspectors should have a clerk to count the supplies. At all points of receiving supplies a sufficient stock should be kept on hand to allow time for inspection, so that the plea of immediate emergency requirement may not be advanced to avoid inspection. In 1904 the city of New York passed for supplies 158,400 claims. This gives some indication, considered with the fact that the city buys annually some 23,000 different items, of the enormous field and variety to be covered. In such a bewildering field lack of specialization is a farce, and altho the basis for proper inspection is specification, the training for inspection develops powers of observation, and upon that ability largely depends the value of the inspector.

The total annual supply bill for the city of New York is $15,000,000, summarized as follows:

Fuel	$2,500,000
Food products	1,800,000
Printed books and forms	1,200,000
Forage	1,000,000
Materials of construction	1,000,000
Office equipment	400,000
Pipes, valves and fittings	400,000
Furniture and furnishings	350,000
Vehicles	350,000
Dry goods	250,000
Total	$9,250,000

So that nearly $10,000,000 worth of supplies is purchased under ten classifications.

The departments purchasing the greater amount of supplies are as follows:

Education	$1,500,000
Charities	1,500,000
Water supply	1,000,000
Street cleaning	1,000,000
Docks and ferries	1,000,000
Fire department	700,000
Bellevue	700,000
Health	600,000
Parks	500,000
City Record (which supplies all departments with books, stationery and forms)	750,000
Total	$9,250,000

So that nearly $10,000,000 worth of supplies is purchased by ten departments.

The important qualifications of an inspector are honesty, knowledge, tact, loyalty and industry. The quality of tact is important because of the relations between the purchasing departments and the department having jurisdiction of finances. Honesty is the first desideratum in an inspector, in that the greater his knowledge and ability the greater harm he may do if he is dishonest. Without loyalty to his chief he is almost worthless.

To illustrate extraneous work which may be achieved by an inspector, one or two instances may serve.

A short time ago the corporation counsel wished to purchase sixty-seven new typewriters and exchange seventy old ones, and requested the advice of the comptroller in the transaction. The matter was referred to the division of inspection. The price quoted for the new typewriters was $5,291.66, and the allowance to be made for the seventy old ones was $1,690, leaving a net cost for the transaction of $3,601.66. The division of inspection, after an investigation, put thru the transaction at a net cost of $2,091.46, thus effecting a saving on this one transaction of $1,510.20.

Prior to 1910 the fire department spent $70,000 each year by contract for horseshoeing. A certain inspector recommended the establishment of a traveling blacksmith shop, to be manned by the laborers employed by the fire department, with the result that the fire department has spent on this work since then $36,000 annually, showing an annual saving of $34,000.

The police department since 1912 has undertaken to do its horseshoeing in the same way.

Prior to 1911 the contracts for horseshoeing in the department of street cleaning were made according to the number of horses in the stable, irrespective of how many horses were actually shod. Since then the expense has been incurred only on the basis of the horses actually shod.

Before 1910 the department of street cleaning bought by contract refills for street broom blocks at an annual expense of $30,000. According to the recommendation of the division of inspection this work has been done since then by the penitentiary on Blackwell's Island at an annual cost of $22,000, effecting an annual saving of $8,000.

(*b*) *Laboratory, Physical and Chemical, and Research.*

A large proportion of specifications now require tests in a physical or chemical laboratory for supplies for which visual inspection is not adequate. From the list of supplies susceptible to visual inspection, the larger single classification of all, that of fuel, including coal and fuel oil, and amounting to at least two and a half millions a year, must be stricken out. Other supplies must be entirely stricken from the list of those susceptible to visual inspection for the same reason. They are cordage, rope and oakum; drugs and chemicals; paints, oils, varnishes, etc.; rubber goods; seeds, plants, etc.; wire rope and wire. Many other supplies are partly susceptible to visual inspection and partly susceptible to physical or chemical tests. These are: Apparatus (laboratory, etc.); arms and ammunition, etc.; cleaning materials and compounds; dry goods; food products; hospital supplies and surgical supplies; iron, steel and other metals; leather, saddlery, belting, hose; materials for construction; materials for the manufacture of prison goods, and lubricating and illuminating oils. By saying that goods are partly susceptible to visual inspection and partly susceptible to physical and chemical tests, it is meant that the finer distinctions of qualities must be shown by such tests, while the grosser distinctions may be determined by visual inspection.

For example, in the case of dry goods, an inspector well trained in that kind of supply will readily see gross differences in finish, nap, weave or thread count, whereas the test for tensile strength must be left to the physical laboratory. In inspecting dry goods an inspector may justly reject supplies delivered on the basis of the delivery and the requirements of

the standard specifications being so gross as to be apparent to the senses. It is only the finer distinctions of thread count and tensile strength that need be left to the laboratory, but an inpector can make a count test himself.

Thruout the kinds of supplies enumerated as susceptible to both methods of inspection, instances similar to the illustration of dry goods frequently happen. In all instances where the inferiority is so great as to be apparent the inspector can protect the interest of the city and save money without reference to the laboratory. Such supplies as drugs and chemicals, medical and surgical instruments, scientific specimens and equipment for physical and chemical laboratories are unsuitable for visual inspection. These goods are delivered to the various hospitals, almshouses, the City College, Normal College, high schools and the Museum of Natural History.

I remember an occasion when I was sent to the College of the City of New York to inspect repairs made on an instrument for measuring the rate of travel of the sun's rays. I had never seen such an instrument before. I knew nothing of its operation, and still less about the repairs, and whether the instrument, after being repaired, performed its functions properly or not. I offer this as an illustration of the farce of amateur inspection of highly specialized supplies. As the city spends about half a million a year for such supplies, a specialist for such inspection should be able to save the city more than his cost, because such supplies have never before been properly inspected.

(c) *Fruit and Vegetable Inspection Device.*

The old-fashioned method of inspecting fresh fruits and vegetables is still in force in the city.

Suppose a truckload of 100 bags of potatoes is delivered. The truck driver throws off one bag from the tail end of the truck, stands it up on its bottom end and cuts the string sewed in the top end; then he topples the bag over flat on the floor and a few potatoes from the top spill out; then he has to take hold of the bottom of the bag and pull it up until the bag is entirely emptied of its contents. A bag of potatoes weighs from 170 to 200 pounds, so that this is heavy work. The same operation is repeated two or three times for two or three more bags to be emptied. If the inspector is in doubt another and another bag must be emptied until he has reached his decision. Please observe that all these bags are taken from the tail end of the truck. When 75 or 100 bags of potatoes are loaded on a truck they are packed so tight that it is practically impossible to pull out the bag in the center, or even bags in random places thruout the load. The knowledge that for inspection bags must be taken from the tail end of the truck offers to unscrupulous dealers the opportunity to place there supplies of good quality and to conceal those of inferior quality elsewhere. Because of this condition it frequently happens that fruits and vegetables are officially accepted by an inspector as of satisfactory quality on the basis of such inspection, and later, upon being used, a larger portion of the remainder, which, on account of the condition described, have not been seen by the inspector, is found to be of decidedly inferior quality.

An invention has recently been made by one inspector engaged in such work to obviate these difficulties. It is an open tray built on a frame on wheels and so designed that its height can be adjusted to that of a truck. This machine is wheeled to the end of the truck and a bag of potatoes placed on a dumping device and turned over into the open tray, spilling its contents into the hopper. All of the potatoes are seen at a glance, and by releasing a lever catch the inspector allows the hopper to dip and the potatoes to run thru a spout into a bag hung below. The operation does not take more than half a minute and there is no physical labor. Not only can all the potatoes in the bag be seen at a glance, but by the elimination of labor and the reduction of time, all or a large proportion of any delivery of such goods can be seen in a short time.

New Metered Water Rates for Salt Lake City

In the interests of economy and efficiency, the water department of Salt Lake City, Utah, has worked out a new plan for assessing water rates on meters. It was inaugurated about April 1.

Heretofore the meter rates have been: Seven cents per 1.000 gallons for the first 100,000 gallons; 6½ cents for the next 100,000, and 6 cents a thousand for more than 200,000 gallons. This system involved complications, inasmuch as the meters measure the water by cubic feet. Much time and labor was required in the water office to reduce all the bills and notices from cubic feet to gallons and figure the bill to each customer.

Under the new system the rate will be figured in direct ratio to the number of cubic feet of water used thru each meter. The rate will be 5½ cents per 100 cubic feet for the first 13,000 cubic feet; 5 cents per 100 for the second 13,000 cubic feet, and 4½ cents per 100 for all over 26,000 cubic feet. This scale approximates the old as nearly as is practicable.

A saving of $250 a year in the cost of making out bills will be effected under the new system, according to C. F. Barrett, superintendent of water works.

The water department also contemplates the adoption of postal card bills to all consumers, a measure that will save the city $600 in postage during the year.

Asphalt Industry in 1915

The asphalt industry as a whole was prosperous in the year 1915, according to a statement just issued by the United States Geological Survey. The natural asphalt, including grahamite, gilsonite, elaterite and bituminous rock, produced and sold at mines and quarries in the United States in 1915, amounted to 75,751 short tons, valued at $526,490. Though this quantity was 5 per cent less than the output in 1914, the reports of the sales of manufactured asphalt derived from petroleum of domestic origin disclose a gain of 84 per cent over the quantity sold in 1914. The total sales of manufactured asphalt amounted to 664,503 short tons, valued at $4,715,583. In addition to this output, refiners in the United States made and sold 388,318 short tons of asphalt, valued at $3,730,436, that was derived from petroleum imported from Mexico.

The decrease in the output of natural asphalt is confined to bituminous rock and is due largely to the keen competition that this type of asphalt is forced to meet in its chief market—the paving industry—with manufactured substitutes.

Statistics just completed under the supervision of J. D. Northrop, of the Geological Survey, show that of the quantity of manufactured asphalt derived from domestic petroleum in 1915 a total of 417,859 short tons, valued at $2,392,576, was marketed as road asphalt and flux, and 246,644 short tons, valued at $2,323,007, as residual pitch, used chiefly for paving.

The output of the Mexican product in 1915 may therefore be subdivided into road asphalt and flux—174,854 short tons, valued at $1,325,201—and residual pitch—213,464 short tons, valued at $2,405,235.

SETTING WATER METERS

AT TERRE HAUTE, IND.

By Jay A. Cravens, Asst. Supt. of the Terre Haute Water Works Company.

This article shows what can be done when plans are laid in advance and are worked out in proper detail. The Terre Haute Water Works Company petitioned the public service commission of Indiana for a change of rates which would have the effect of greatly increasing the number of meters. In anticipation of the commission's decision the plans were made and the meter boxes were made as described, so that when the decision was rendered establishing the new rates in February the company was ready to begin work at once. The very efficient advertising for which this company is noted increased the applications for meters even more rapidly than had been expected, but the plans were so well laid that every application was taken care of promptly and properly. The engineer in charge of the work supplied the data for the article.

LAST year the Terre Haute Water Works Company decided to set a considerable number of additional water meters in frost-proof outside meter boxes.

The preliminary office work entailed a complete list of all meters to be set, and when compiled showed a total of about 2,250. This was made up by going over the ledgers, selecting all services which did not have purely domestic use, i. e., without sprinkling, or, in other words, those places which did not comply with the new rules in effect February 1, 1916, for flat-rate services. Four sets of lists were prepared, one of which was filed with the Board of Public Works, the board issuing a blanket permit covering all on the list. A remarkable thing about the making up of this list was the popularity of the use of meters, necessitating a daily increase in the number upon our list. Some days as high as thirty to forty signed up meter applications. Each day four lists were made up of the additional ones, one going to the city for the blanket permit, the others being added to our files of lists. At this time letters were sent to all consumers who had sprinkling service only during other years. Other notices were sent to consumers who had not been using water for some time and to other residents who had never used water, but where mains were available. Thru these means and thru the voluntary signing up of people who demanded meters the number on the lists was increased to about 3,000. While the water company, under the new rules, has a right to install meters on all services upon notice, the consumer also has the right to demand a meter. The great increase in the number to be set had a marked effect upon the original plans, due to the using up of all tile and the exhaustion of the number of meters on hand.

During the summer and fall of 1915 the necessary concrete tiles were made at the pumping station. For this purpose eleven forms were used, ten of them for making a tile 15 in. in diameter by 3½ ft. in length and one for tile 18 in. in diameter and 4 ft. in length. The latter form was purchased from H. W. Clark in July, 1911, at a cost of $17.50: the other ten were purchased in three lots from the Ford Meter Box Company, one in May, 1912, at $12.40, four in January, 1914, at $14.88 each, and five in October, 1914, at $12.40 each.

Day labor was used and was paid 20 cents per hour. Portland cement was obtained at $1.98 a barrel delivered, gravel at $1 a yard, and the mixture used was 1 of cement to 3 of fine gravel and sand. While the average number made each day was ten, it was possible in dry weather to remove the forms from the first set and in this way make twenty tiles a day. The average cost of the tiles was about 45 cents each.

The accompanying cut shows the general set-up when installed, the surface of the ground coming flush with the top of the cover. The tile shown in cut is the small size mentioned, 15 in. inside diameter and 3½ ft. long. The metal cover shown is 9 in. high, and at the top 9½ in. outside and 8 in. inside in diameter. Two covers are provided, shown at bottom of cut, one for frost protection (shown flat) and the other the locked top cover (standing). The yoke shown at the top of the risers in the setting makes a rigid connection, no coupling being necessary. For removing it is only necessary to withdraw the wedge shown in cut, the meter then being ready to lift from the well. Washers are used at the inlet and outlet ends on the meter.

The average cost of the yoke or rigid setting for meter and the cover was about $3.75. It must be borne in mind, however, that these materials were contracted for before the advance in prices. The risers shown average about 6 ft. of w. i. galvanized pipe to a setting. The cost of pipe at 7 cents a foot, with four threads at 5 cents each, made the total cost of the pipe about 62 cents; two ells at 5 cents each were used in each setting.

Ten canvas fitters' bags were equipped, each containing one 10 and one 14-in. pipe wrench, one ratchet die, one rasp, one turnpin, one hammer, one oil can, one rule and one pipe cutter.

At first the foreman on the job, with his list of places to be metered, endeavored to look after all the work, and in addition locate the service boxes. This, however, proved too much for him, and before the work had progressed very long it was found best to have all boxes staked off in advance of the diggers. This helped very much in speeding up.

Altho all customers could not be satisfied in setting the meters, everything possible was done toward this end. Where the service box was near a tree or shrubbery the householder was consulted and his wishes were complied with whenever possible. Extra expense was incurred in many places where the meter had to be set a distance away from the service to avoid cutting roots of the trees, the men having strict instructions to avoid injuring them, unless absolutely necessary.

No special arrangement had been made for selecting the men before the work started other than advertising that help would be needed. With the exception of three or four of the regular job men, all were inexperienced on meter setting.

The first two weeks of the work all materials were delivered by the company's truck, the driver, with one helper, looking after this. When the men gained a little more experience, teams had to be obtained to help in delivering to keep up with the work.

The tiles and tops were distributed two or three weeks in advance to advertise and get new customers to come in and sign up contracts for the water.

Three distinct divisions of the work were made: First came the diggers, who uncovered the service pipes; then the meter-setters, who made all the necessary connections, and

then the gang which set the tile and covers and filled in. Slight changes were made in this as the work advanced. It was found that one or two of the laborers could handle the setting of the tile and cover, and the best ones were selected to do this. They were followed up by the men who filled in and cleaned up.

As considerable extra excavated material was left at each site, it was necessary to have one to three teams all the time to haul this away.

The foreman made many changes in the men, as he believed in weeding out the undesirables, which he did right along as fast as he could replace them. In time he had a fairly well balanced gang for the work.

The work was begun on February 24, 1916. The first day 33 meters were set, with a total of 140 hours of labor, the latter not including the foreman's time. The total cost of labor on meter setting was $1.44. This included foreman's time and the truck at $10 a day and one team. It will be noted that the cost per meter the first day was less than the average. On this day, however, the gang was smaller, easier to look after, and included some of the regular shop men accustomed to the work.

Detailed cost of the labor on the setting of meters has been made up for the first two weeks only. On the first full week ending Friday night there were two bad days, on which no work was done. For this week there were 898 working hours and 179 meters were set at an average cost for labor only of $1.68. This does not include overhead charge. On the second week there were five working days and 278 meters were set at an average cost of $1.53. The total number of hours of labor was 1,488. The largest number of meters set in one day was on March 24, and was 135. On 27 days in which the weather and other conditions did not interfere with the work too much between 50 and 100 meters were set each of these days, and on 10 of these days over 100 were set.

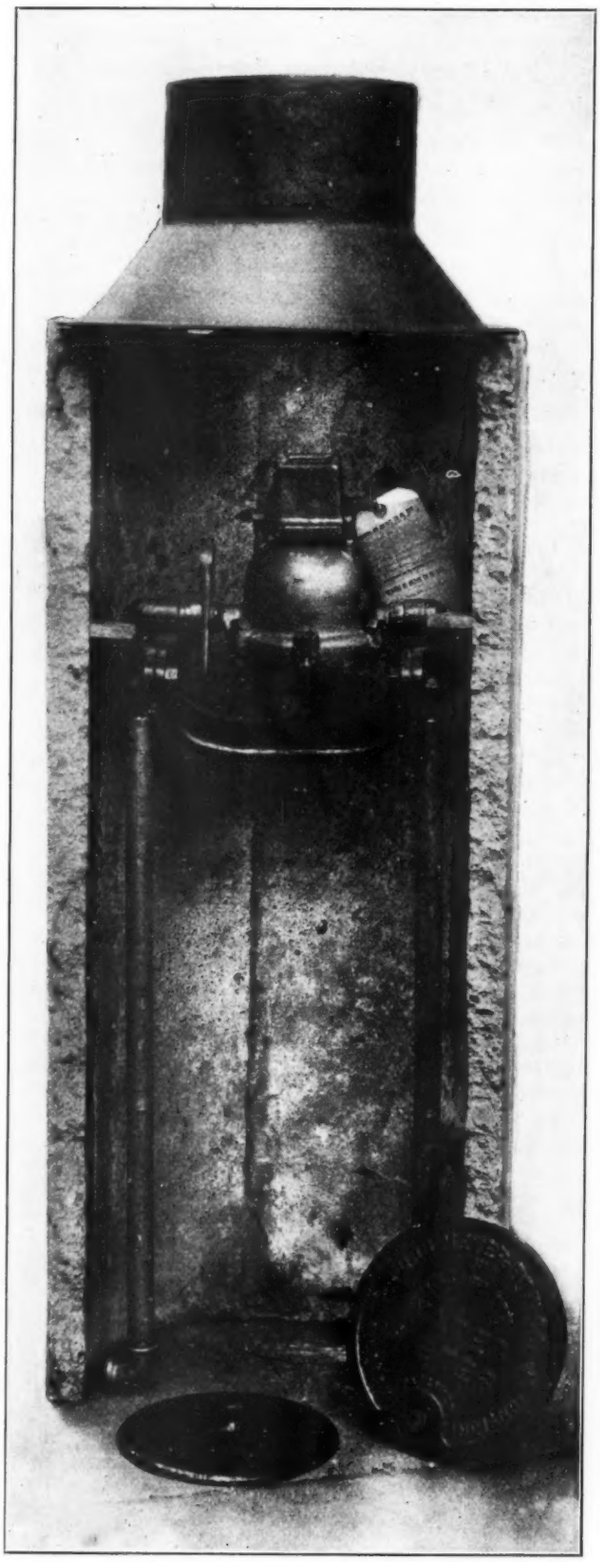
Due to the increased number to be set, we ran short of tiles, and various ways were tried to keep up on them. First, the forms were taken to one of the large concrete manufacturers here and his force turned out as many as possible each day. As it was cold at the time, the work did not progress very fast. As one of the large tile manufacturers is situated near by, we were able to obtain some stock tile which were 15 in. in diameter and 2 ft. in length. At the same time a contract was made with one of the companies to supply us with a special tile 15 in. in diameter by 3 ft. in length. Running short on this material held us up for some time. Delays were also occasioned by difficulty encountered in getting the extra needed number of meters and yokes and covers, due to the manufacturing situation at the time.

The record for the number of meters set in a day was made by one of the men engaged at that time who had no previous experience and was not a pipefitter, his record being 22.

The average cost for meter setting when the large force was working was approximately $7.50, which included all labor and hauling and the material used, with the exception only of the meter. This does not include any overhead.

In considering the cost of setting it must be remembered that the work was begun in the spring of the year and there were many days of rain and snow, which seriously interfered with but did not stop the work. In digging, too, it was necessary to pick thru the frosted ground, which otherwise would have been easy shoveling. On some of the cold nights, where it was necessary to leave holes open, risers and meters were frozen and extra time was required to thaw them out, adding to the cost.

As it was felt that some were missed that should be metered, but could not be detected by the book records, a hurried survey was made one morning after a snowstorm, attention being paid to those using outside fixtures the year round. The results of this inspection increased our list considerably, as at many places tracks in the snow were found leading to several houses in the neighborhood, and the flat rate was being paid only for the residence at which the hydrant was located.



METER BOX AS INSTALLED IN 15-IN. TILE. THE SURFACE OF THE GROUND COMES FLUSH WITH THE TOP OF THE COVER. THE TOP, SHOWN LYING FLAT ON THE GROUND, IS FOR FROST PROTECTION, AND THE ONE STANDING IS THE LOCKED TOP COVER.

METHODS OF CONCRETE SEWER CONSTRUCTION

By J. F. Springer, New York City.

Several varieties of design and construction of concrete sewers are described which, with the photographs, show the adaptability of concrete to such construction, making many economies possible in materials and labor as well as in special forms of construction and of transmission of materials which are not possible with other materials. The descriptions of actual work done make the article specially practical and valuable.

SOME of the characteristics of concrete lend themselves splendidly to sewer construction, but no material is so perfect as to be ideal in all cases. Concrete, in other words, has its faults as well as its advantages. Prominent among its faults are its permeability to water under pressure and its lack of tensile strength. These defects are both of them more or less capable of elimination. Steel reinforcement supplies to some extent a means of combatting tensile weakness and is rather peculiarly fitted for this duty because of the fairly close correspondence of its co-efficient of linear expansion with that of concrete. Permeability may be fought by giving the concrete a maximum density. Unfortunately, density means an increase in the percentage of the most expensive ingredient, portland cement.

Concrete sewers may be built of concrete pipe or as concrete-lined excavation. In both cases the sewer must be strong enough to resist the crushing pressure on its arch of the weight of earth or other load on top of it and pressure in any other direction on account of water in the ground or compressible or movable soil, as well as pressure of water from within in case such pressure is possible for any reason.

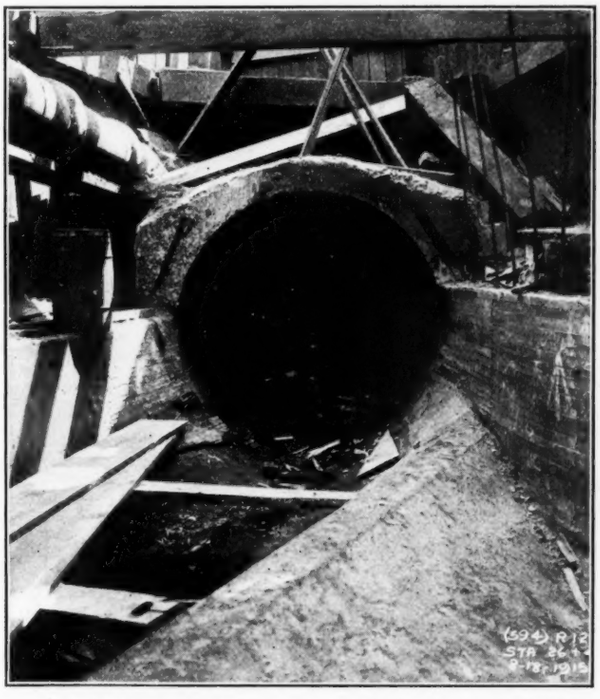
In illustration of a portion of the foregoing remarks, may be cited the Stieren street storm sewer at San Antonio, Tex. The main line is made of concrete, some of it being 3½ and some 4 feet in diameter. Part of this line was given a reinforcement of wire mesh, part was not reinforced. Where the reinforcement was used, it weighed about 1 ton to, say, 185 linear feet of conduit. It was bent to shape by workmen using hammers, the resulting section being not a circle, but octagon. Steel forms were employed and the tube was cast in position. The typical section shows a cylindrical shell with a flat horizontal surface where the sewer rests on the soil. The trench in which this pipe was poured varied in depth from 6 to 12 feet. The concrete was similar to that made by the formula 1:2:4, the river gravel containing an excess of sand. Crushed limestone was used to offset this. This ability to use local materials in large part in making the concrete has done much to popularize it for sewer construction.

At Los Angeles, Cal., we have an example of a concrete pipe sewer over 5½ miles long. The pipe in this case was cast in sections above ground and then allowed a period for maturity before being put in final position. The minimum period for maturing was 15 days. Steel forms were employed, and the sections cast were 3 feet in length, whatever the diameter might be. A fairly dense concrete was employed, following the formula 1:2:4. One-half mile or more of the sewer consists of 66-inch pipe, and 5 miles of pipe, varying from 34 to 60 inches in diameter.

The joints were made by means of a cement mortar, 1:2 mixture. Heavy roofing paper or sheet iron was employed on the exterior of the sewer to provide a form for the grout. When all was ready, the grout would be poured from one side until it appeared on the other, when pouring would be completed from the other side. If, for any reason, the grout failed to appear as expected, the joint was dug out and the difficulty was removed. A 3-foot length of 60-inch pipe, having a wall thickness of 6 inches, weighed 3,600 pounds.

At other points along this De la Brea sewer at Los Angeles, the size of conduit required was much greater, 1,240 linear feet having dimensions of 12¾x9 feet, and 1,621 linear feet being somewhat smaller, 10x8 1/3 feet. All of this larger size was constructed of reinforced monolithic concrete. On other sections, monolithic concrete, not reinforced was used for cross-sections of large but varying sizes. Part of the large construction consisted of invert and arch, the latter provided with numerous reinforcing rods.

An interesting instance concerned in the laying of premolded concrete shells occurred not long ago in Philadelphia. Two varieties of shell were used, a 36-inch circular shell and an egg-shaped shell, 36x42 inches in dimensions. The pipes



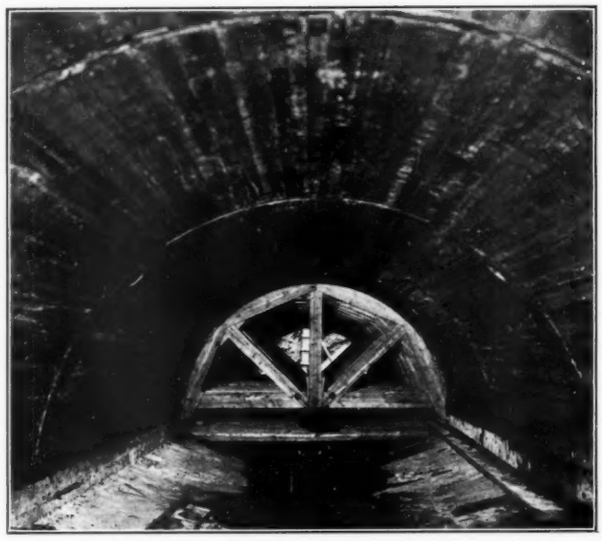
A CONCRETE SEWER HERE DISCHARGES ITS ORDINARY FLOW OF SEWAGE INTO THE CHANNEL TO THE INTERCEPTING SEWER RUNNING OFF TO THE LEFT TOWARD THE SPECTATOR. WHEN SUFFICIENT STORM WATER COMES TO OVERFLOW THE DAM SEEN IN THE FOREGROUND, THE EXCESS RUNS OFF IN THE OVERFLOW SEWER UNDER CONSTRUCTION AT THE RIGHT. NOTE THE REINFORCEMENT IN THE WALLS WHICH WILL BE EXTENDED UP TO RECEIVE A FLAT TOP OR AN ARCH OF CONSIDERABLE RADIUS OVER THE WIDE SPACE AT THIS SEPARATION OF THE WATERS. NOTE THE METHOD OF SUPPORTING THE EXISTING VITRIFIED PIPE LINE DURING THE CONSTRUCTION OF THE NEW SEWER.

were in general made in short lengths of 4 feet each. The circular shell had a wall thickness of 4 inches. Triangular steel mesh was used for reinforcement. It was set concentric with the shell and 1¾ inches back of the interior surface. Similar mesh similarly placed was used in connection with the egg-shaped sections.

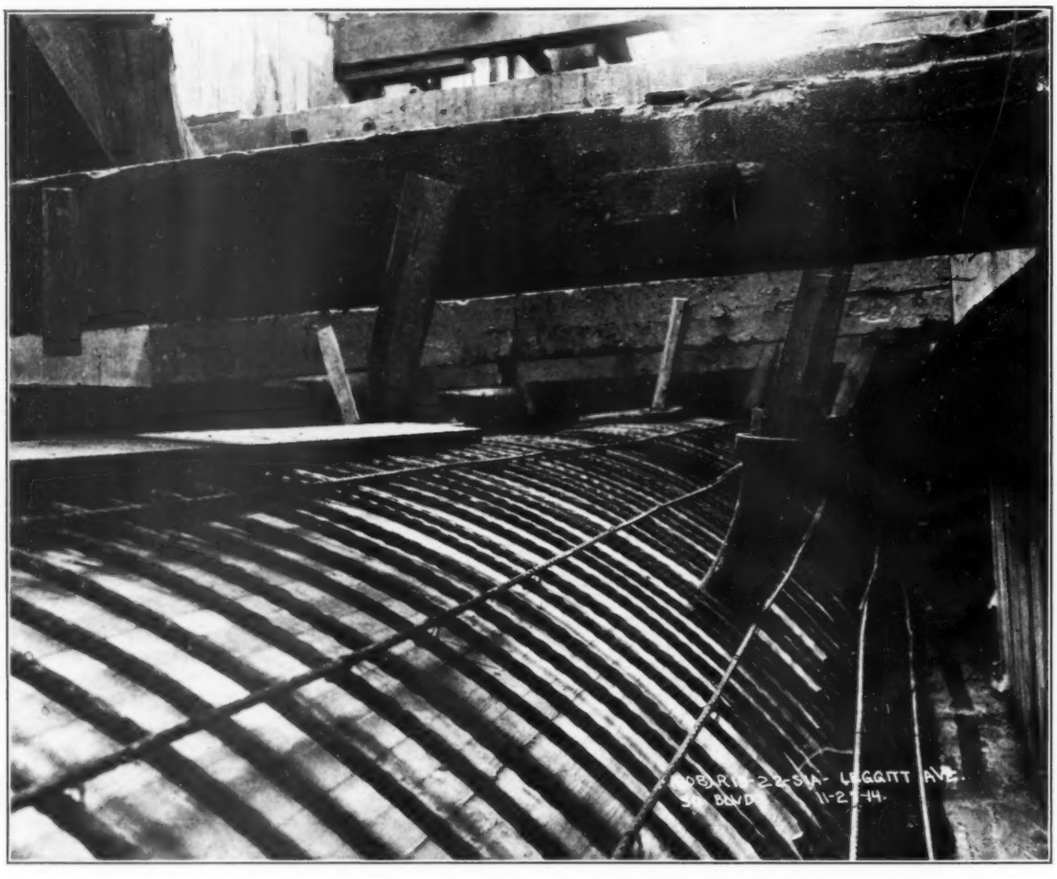
The forms were of metal and consisted of two cast-iron rings for top and bottom of the pipe length and of two sheet-steel shells for the body. Clamps and bolts held all together. The inner shell was provided with a horizontal shoulder formed of angle bar, upon which was placed a thin steel disc. This disc closed the interior of the mold and served as a table from which concrete might be worked into the form. The mode of providing for the projecting steel mesh at the socket end was as follows: The cast-iron ring for the socket end was laid on the working surface and the inner shell of the form put in place. A slot was provided in the cast-iron ring of such dimensions as to make it a convenient receptacle for the projecting reinforcement. The piece of mesh was now set in place in the slot and the latter was filled up with sand. The purpose of the sand was to prevent the entrance of concrete when the pipe was cast. The cylindrical shell of mesh was in one piece, being made from fabric wide enough for one length of pipe. One roll of the material weighed about 450 pounds.

The socket and spigot ends had such forms as would be produced by counter-boring in the one case and exterior recessing in the other, and when put together the continuity of the inner cylindrical surface was not interrupted. When the joint was prepared, the two parts fitted together with the projecting reinforcement between them. A hole was provided at the top thru which grout might be poured. In this way the upper part of the joint was sealed and reinforcement included in it.

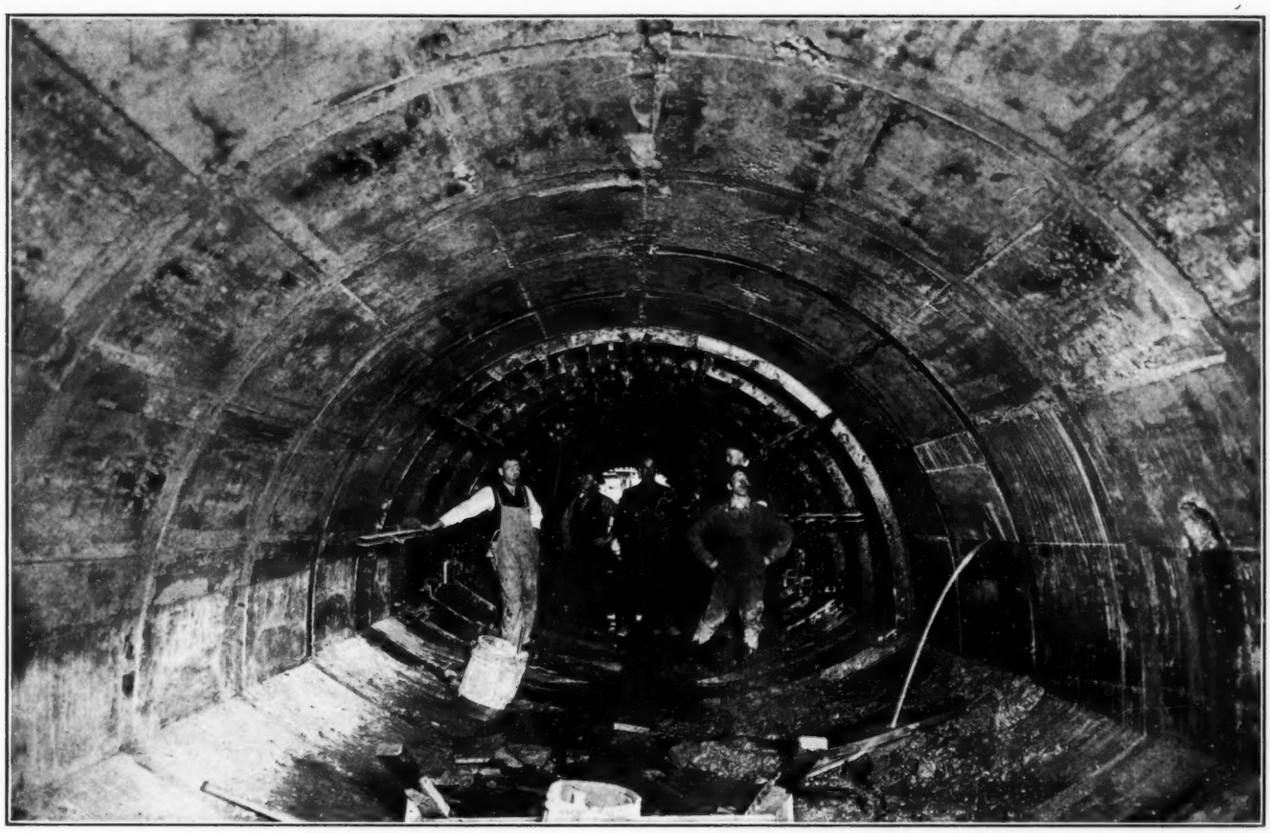
The aggregate used in the concrete was made in proportions 1:2:4 from gravel or sand and trap rock crushed to a size varying from ¼ to ¾ in. The concrete was mixed rather wet so that it flowed readily into the form. It was put in place by an experienced man armed with a spade made from a steel plate which had been curved a trifle. The effective handle was about 7 ft. long. In spite of every effort in placing, air holes would sometimes form on the surface of the pipe. Paraffin oil was used on the forms to prevent adhesion of the concrete.



CIRCULAR ARCH AND INVERT WITH DIFFERENT RADII AND A LOW VERTICAL WALL BETWEEN, AS USED IN NEW YORK. FORMS WITH WOODEN RIBS, BRACES AND LAGGING WERE USED IN THIS CONSTRUCTION.



OUTSIDE OF FORMS USED IN CONSTRUCTING THE SEWER SHOWN IN THE PRECEDING PHOTOGRAPHS, SHOWING THE WOODEN LAGGING, THE DEFORMED BAR REINFORCEMENT, CIRCUMFERENTIAL AND LONGITUDINAL, THE METHOD OF HOLDING HOUSE-CONNECTION PIPES IN PLACE UNTIL CONCRETE IS POURED AND SET, AND THE TRENCH BRACING.



CIRCULAR ARCH AND CIRCULAR INVERT OF LARGE RADIUS. DESIGN USED IN THE NEW SEWER CONSTRUCTED IN CONNECTION WITH THE FOUNDING OF THE UNION DEPOT BUILDINGS IN CHICAGO. PRESSED STEEL RIBS ARE USED IN THE FORMS AND WOODEN PANELS COVERED WITH SHEET STEEL FOR LAGGING.

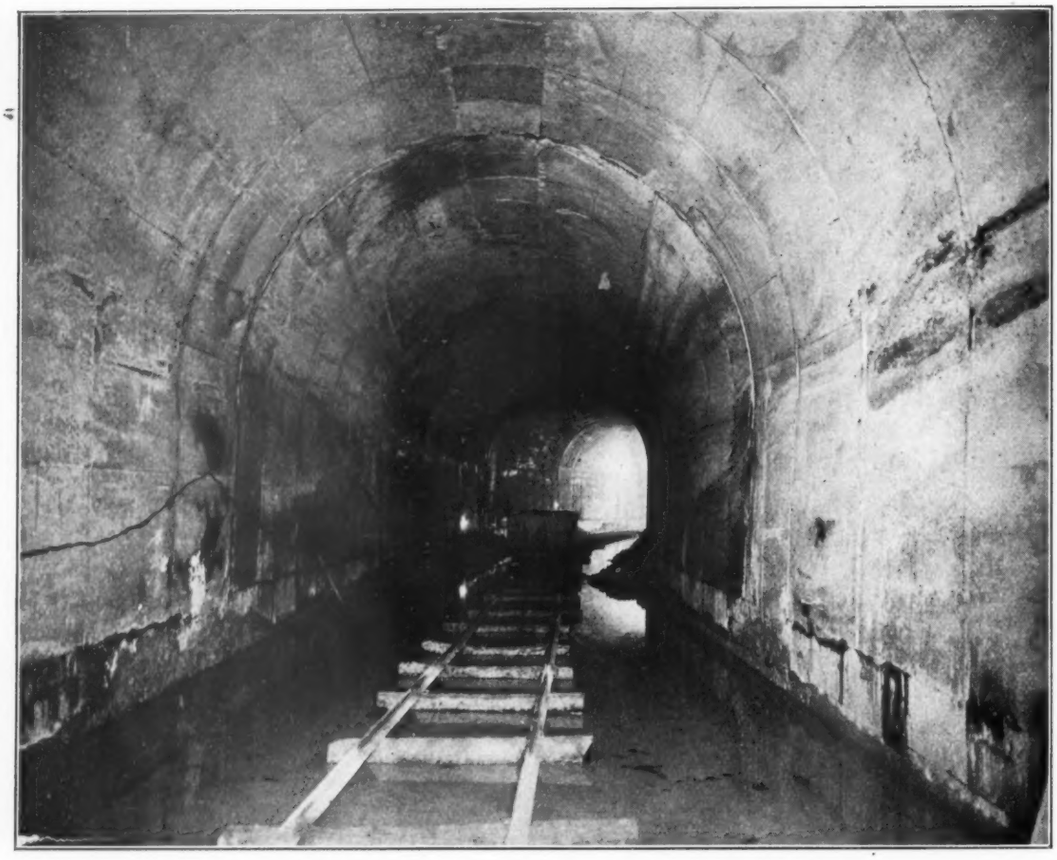
Some trouble was nevertheless experienced. A 12-hour vapor bath was tried, but some doubt had been expressed as to the desirability of using this remedy, because of the considerable difference in temperature between top and bottom.

The trenches were excavated about 1 ft. wider than the pipes. The depth was carried to a level about 3 in. lower than the point determined for the bottom of the sewer. Instead of resting the concrete shells directly on the soil, a concrete cradle of 1:3:4 mixture was provided. The cradle was broad enough to provide a curved rest 12 in. deep. How to seat the pipe on the cradle seems to have required experimentation. After some trial, the method adopted required the concrete cradle to be brought up to within about ½ in. of the proper level of the bottom of pipe. Three days or more were allowed for hardening. When all was ready for actually setting the pipe, a mortar was spread to the depth of ⅝ in. and the pipe was settled upon it. The making of the joint then followed, whereupon the cradle was brought up to its required height.

A DESIGN USED IN NEW YORK INVOLVING A CIRCULAR INVERT WITH LARGE RADIUS, VERTICAL SIDE-WALLS AND FLAT SLAB TOP. THE CLEAR MARKS OF BOARDS AND NAILS SHOW THAT WOODEN FORMS WERE USED HERE ALSO.

The making of the joint was effected "by first overlapping the reinforcement projecting into the socket and pressing it into position, then applying a stiff mortar to the lower half of the socket from the inside of the pipe, and grouting the upper half from the outside thru the pouring hole at the top. The mortar was pressed thru the reinforcing until the lower half of the socket was completely filled, when it was troweled to a smooth finish; a steel band 6 in. in width was then sprung around the entire interior of the pipe and keyed tight to prevent the escape of the grout, the exterior being sealed with a coat of stiff mortar covering the joint on the entire upper half of the pipe and extending about 12 inches below its center. While the grout was being poured a heavy steel wire was worked in the joint to prevent choking and to expel the air. This was continued until the joint was completely filled and the grout was brought to the top of the pouring hole. The steel band was removed in 24 hours and the joint smoothed to a finish on a plane with the interior surface of the pipe." Both the mortar and the grout followed the formula 1:2.

As to relative cost of such sewers as compared with brick, it is interesting to note that several years prior to actual construction, but at a time when labor and material costs were about the same, bids were received for brick construction. The lowest bid for the circular 36-in. sewer was $7.95 per lin. ft. The lowest bid for concrete, the concrete bids being re-



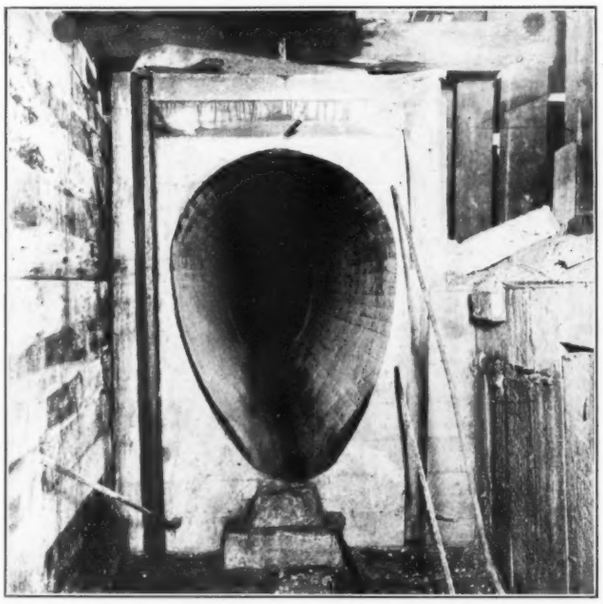
A SECTION OF MILL CREEK SEWER, ST. LOUIS, MO., WHERE THE SEWER HAS A SEMI-CIRCULAR ARCH, VERTICAL SIDE-WALLS AND AN INVERT WHICH IS ALMOST FLAT. STEEL FORMS SEEM TO HAVE BEEN USED IN THIS CASE. THE WATER STANDING ON THE BOTTOM MAKES IT DIFFICULT TO SEE THE DESIGN AS IT REALLY IS. THIS SECTION OF THE SEWER IS A ROCK TUNNEL LINED WITH CONCRETE WHICH WAS PLACED BY COMPRESSED AIR.

ceived presumably about the time of construction, was $5.10 per lin. ft. of sewer. Here is a very substantial difference. However, for the egg-shaped construction, the lowest bids were about the same, the brick having a slight advantage. The prices included excavation, backfilling and repairing.

It is considered to be a bad condition when a reinforced concrete sewer develops any kind of cracks, even those as thin as hairs. There is then danger that the reinforcement will suffer corrosion. It should be remembered that the relation between concrete and steel is a two-fold one. The steel is there to furnish tensile strength; the concrete has the duty of protecting the steel. It is valuable then to know that experiments carried out for the benefit of the city of Philadelphia showed that a concrete cradle provided a much better support for reinforced concrete pipe than a bed of sand. The experiments coverd both circular and egg-shaped shells, the latter having a flat base. The superiority was observed for both types, but was more pronounced in the case of the circular pipe. The loading against which protection was sought was similar to that of a backfill.

As to permeability—that is, liability to leakage—if concrete is properly made and in accordance with the formula, 1:2:3½, no trouble should ensue for pressures amounting to 5 pounds per sq. in. That is, a constant head of ground water of 11 ft. is permissible. It was brought out in the permeability tests at Philadelphia that pressure on freshly poured concrete promotes water-tightness. The parts of the shells which constituted the upper halves when in the forms were found more permeable than the other parts. My suggestion, growing out of this, is to the effect that the forms should be so made as to make it possible to put the whole shell under pressure during the early period.

The Philadelphia experiments are thought to warrant placing the reinforcement (wire mesh) close to the inner face of the sewer. This remark is to be understood as applicable to circular sewer pipes 3 ft. or less in diameter and to egg-shaped pipe whose greatest diameter is no larger than 3 ft. The typical thickness of concrete over the mesh on the interior was 1¼ in. With reference particularly to the question whether this amount of concrete is sufficient to protect the



AN EGG-SHAPED SEWER LAID ALONGSIDE THE SUBWAY CONSTRUCTION IN SEVENTH AVENUE, MANHATTAN BORO, NEW YORK CITY, OF REINFORCED MONOLITHIC CONCRETE. THE MASSIVE CHARACTER OF THE STRUCTURE AND THE ELABORATE PROVISIONS FOR A WATER-TIGHT JOINT WHEN THE SEWER IS EXTENDED ARE CLEARLY SHOWN IN THE PHOTOGRAPH, ALSO THE NATURE OF THE FOUNDATION CONSTRUCTED FOR IT. WOODEN LAGGING WAS EVIDENTLY USED IN THE FORMS.

steel itself, may be cited ¼-in. square bars in the City Hall pavement at Philadelphia. Such bars were placed 1 or 1¼ in. from the surface. A piece of such rod buried 1¼ in. was examined, after 19 years of service, by Mr. E. G. Perrott, who states that there was "no evidence of corrosion or rust of any kind." However, too much reliance must not be placed upon one or two instances.

The Philadelphia experimentation developed that it required an internal hydraulic pressure of 25 pounds per sq. in. to crack the pipe (36-in. circular). This is equivalent to a head of 57 or 58 ft.

Some of the pipe tested at Philadelphia was given a hot vapor bath for about 12 hours, the temperature ranging around 100 degrees. This procedure is advantageous to the contractor because it permits the forms to be removed the day after pouring. Furthermore, concrete set under these conditions could be placed readily in very cold weather. However, the advantage to the purchaser was scarcely proved. It seems that pipe cured by this process gave rather erratic results under test. A steady increase of strength with age, as is the case with concrete ordinarily cured, was not to be depended upon. Some doubt must therefore follow this procedure.

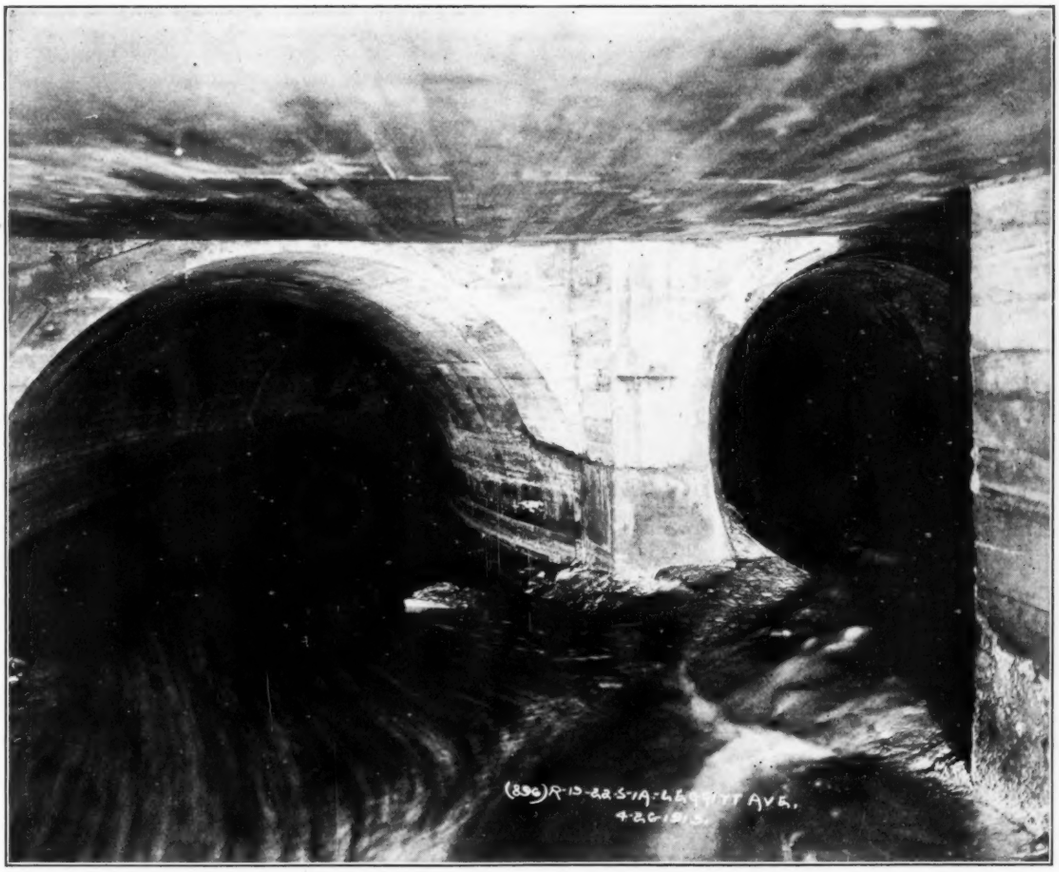
Seattle has put in some 21 miles of sewers in recent years. On one section something over 2 miles long, brick and concrete have been used in conjunction. The cross-section is a circular one, 12 ft. in diameter. This big conduit is largely an example of tunnel construction. The arch is brick and the invert concrete.

Chicago is building a big intercepting sewer in the southern part of the city. It will be 10 miles long and cost some $3,800,000. A horseshoe section has been adopted. A mile and a half of the sewer runs mostly thru a section where the ground is low and swampy. A stiff blue clay lies beneath the upper layer. The section of the sewer in this district is 13x10.4 ft. Monolithic concrete is the material.

The general mode of procedure was as follows: A concrete mixer with a steam engine and boiler shifts upon a track along one side of the trench. Dump cars bring up the material, each car having on board just about the right amount for one charge into the ¾-yd. mixer. A charging hopper is swung down to receive the materials from a car. When the concrete has been mixed, it is chuted to the point of use. The chute has two hinged sections which may be successively thrown up to shorten it. Naturally, the long chute is used when delivery has to be made low down in the trench, and the shorter lengths as the placing rises to the top of the arch. The contractor used wooden forms for the arch at the beginning, but later on used a type of form which consists of steel ribs and wooden panels, the latter being faced with steel sheeting. With the steel forms, the short length of sewer is poured in two operations. First, the invert is cast, wooden forms being employed. Then, the side and arch forms are put in place and the pouring is carried to completion. A 24-hour interval is allowed the invert for setting before the second operation is begun.

At St. Louis, the Mill Creek sewer is a notable piece of concrete construction. The section is in general a horseshoe standing on a rather flat invert. Exteriorly, the side walls are vertical. On the interior, however, the typical open-cut section has inclined sides, the widest part of the interior being about half-way between top and bottom. The exterior sides also incline in the same direction when the rock extends above the springing line. The material is, in general, reinforced monolithic concrete. This sewer is a big one, a typical section being 16½x16½ ft.

A part of the sewer is in tunnel, nearly the whole of this section having vertical side walls and circular arch. The concrete here is specified to be such that the fine aggregate has one-half the volume of the coarse aggregate. To every 4½ cu. ft. of coarse aggregate, 94 pounds of cement are required.



JUNCTION OF HORSESHOE SHAPED SEWER, ON THE LEFT, WITH A CIRCULAR SEWER, ON THE RIGHT. CONCRETE IS SPECIALLY ADAPTABLE TO SUCH CONSTRUCTIONS AS THIS, AS THE POSSIBILITY OF MAKING VERTICAL WALKS AND FLAT ROOFS RENDERS UNNECESSARY THE BELL-MOUTH ARCH INTERSECTIONS SO NECESSARY AND SO DIFFICULT TO DESIGN AND CONSTRUCT IN MANY PLACES WHEN BRICK OR STONE IS THE STRUCTURAL MATERIAL USED.

A good deal of concrete placed at St. Louis, especially in the tunnel portion, was put in position by compressed air. The materials were dropped down thru vertical holes connecting the excavation with the surface. They were received in a hopper which stood over the mixer. The mixing apparatus consisted of a single chamber tapering underneath to about the size of the transmission pipe. At the top, this mixer had a door opening downward—that is, inward. All the materials, including water, were put in thru this door, whereupon it was closed. The interior of the mixing chamber was not provided with paddles or other mechanical devices for mixing. In fact, the mixing of the materials was accomplished by manipulating two jets of compressed air which discharged when desired into the chamber. One jet was located at the top, the other at the bottom. The lower jet was directed horizontally and was located at the elbow of the discharge tube. Part, perhaps a considerable part, of the mixing was probably accomplished in the transmission pipe immediately after discharge from the mixing chamber. After the charge was jostled by the jets, it was shot off thru the transmission piping.

The pipe line for this system may be added to at will until it is 900 or 1,000 ft. long. In the present case, it seemed convenient or desirable to use about this length, the concrete being carried along the tunnel in one direction up to the maximum length of the pipe line and then in the other direction up to the maximum length. In this way about 1,900 ft. of tunnel could be dealt with from one position of the mixer. Turns could be made readily, provided only that they were not too sharp and that the interior surface was normally smooth. The turns might lie in any plane—horizontal, vertical or oblique. The size of the transmission line used at St. Louis was, if I am not mistaken, 8 in. in diameter. A somewhat smaller size may be used, but the maximum size of coarse aggregate then permitted is reduced. In transmitting it is important not to let the pipe get full of concrete anywhere. An experienced man, it is understood, has no real trouble. The air pressure during mixing may be used in one or the other jet up to 80 pounds or even more. In actual transmission, the pressure may be cut in two after the initial dislodgement is effected. The concrete often or generally travels at the rate of 50 ft. per second in this system, so that tamping is unnecessary. It is especially suitable for placing concrete overhead, as gravitation is overcome by the drive of the air. It is not necessary that the concrete be especially wet. Naturally, one will select pipe having a smooth interior and which may readily be connected up. Lap-welded, merchant steel pipe with flanges welded on would appear to be nearly ideal. A pipe-line system such as this has a strong appeal in connection with sewer work, especially where the sewer is a small bore tunnel. The pipe affords a very compact means of transporting the concrete. It is easily lengthened and may be used again and again.

There is another system of placing concrete which is coming into notice and which has its strong points in sewer construction. This is a system which uses a special mixer and atomizer and transmits, like the compressed-air system, thru a pipe line, but uses superheated steam as the driving power. It has been used on tunnel work in connection with two old stone-lined water conduits for whose maintenance the Delaware, Lackawanna & Western R. R. is responsible.

The Public Service Commission of the First District, New York State, exercises in New York City, amongst other duties, a supervision of certain sewer construction. Four of the accompanying photographs show examples of concrete construction carried out under their care.

STREET CLEANING IN NEW YORK

John T. Fetherston, commissioner of street cleaning of New York, under the mayor of the city, is the first such commissioner the city has ever had who was experienced in the actual cleaning of streets. He has the highest executive ability of any commissioner in the history of Manhattan boro except Col. George E. Waring, which has been demonstrated in the thoro manner in which the problem of snow removal has been solved and the comparatively low cost at which this work has been done for heavy snowfalls, as compared with former records of completeness, speed and cost of removal. His work in this line has been described in recent numbers of MUNICIPAL ENGINEERING.

There are several obstacles in the way of the highest efficiency and economy in carrying out the work of the department, and Mr. Fetherston has obtained from Richard T. Fox a full report after a thoro investigation of his work and the conditions under which it is done, with recommendations of a plan for installing a model street cleaning district in Manhattan boro to serve as an object lesson on street cleaning methods and results on which to base extensions of the system thruout the city, as well as to serve as a ground for experiments in new machinery and methods.

Mr. Fox was for seven years prior to 1902 connected with the department in various capacities, and has for some years been in executive charge of the Citizens' Street Cleaning Bureau of Chicago.

Mr. Fox gives a brief history of the New York street cleaning department, showing its close connection, with but one or two exceptions, with the political machinery in the city and the consequent comparative inefficiency of many of its 7,000 employes, contrasting this with the independent administration of Colonel Waring, who was able to produce far better results with very little increase in cost, because he could employ competent men, discharge incompetents and develop a system and an esprit de corps which produced co-operation and a desire of each man to do his full duty. The removal of this handicap from Mr. Fetherston's department is strongly recommended. Another difficulty is the necessity under the present financial plans of the city for estimating months in advance the various items of expenditure that detailed appropriations may be made. It is evidently impossible to do this accurately in a business which depends so much upon the weather and the varying conditions of traffic, building operations and street repairs.

Detailed recommendations as to the establishment of the model district are made and studies of methods developed by Mr. Fox in his Chicago organization are given in great detail.

In brief, Mr. Fox favors the hand cleaning of streets with brush and pan, each man patrolling the area of his district rapidly enough so that each dropping of dirt can be picked up within fifteen minutes, thus preventing drying and plastering over the surface as much as possible. He includes sidewalks in the street area for cleaning. This hand work is supplemented by flushing with pneumatic or pumping motor flushers at night to remove the fine dust not touched by the brooms.

The standard of cleanliness is one very difficult to define, but Mr. Fox has defined it as above for Chicago, and shows that it is higher than the standard in New York and removes 50 per cent. more dirt.

The large cities will doubtless long have much horse traffic, tho the percentage of automobile traffic has vastly increased. As the use of the horse on city streets is reduced the street cleaning problem will become less complicated and will more nearly approach a condition of police regulation of littering the streets

SOME COMPARATIVE TESTS

OF THE WEARING QUALITIES OF PAVING BRICKS, CONCRETE, MORTAR AND NEAT CEMENT

By F. L. Romar, Testing Engineer, Illinois State Highway Department.

THERE are at present very few data on which to base reliable estimates as to the relative length of life of concrete and brick pavements, when the wearing qualities of the materials alone are considered. The following experiments, while in no way conclusive as to the comparative value of brick and concrete pavements, have brought out a number of interesting facts in regard to the comparative wear of brick and concrete blocks, and also as to the comparative wearing qualities of neat cement, mortar and concrete.

It should be kept in mind, however, thruout the following discussion, that concrete in a pavement is, with the exception of the joints, in a continuous slab, and will therefore show much better wearing qualities, as compared to a brick pavement, than comparative tests of concrete blocks and paving bricks would indicate.

Description of Tests.

The experiment consisted of preparing blocks of concrete, mortar and cement of a standard paving brick size (3½ by 4 by 8½ in.) and submitting them, when 90 days old, to the rattler test for paving brick.

The same cement was used in the preparation of all of the blocks, and the same sand was used in the mortar and concrete blocks. The analysis of the materials is given in the last portion of this paper.

The quantity of water used was such as to give a cement paste of normal consistency for the cement blocks, and such as to give mortar and concrete which could be floated without tamping, but which were not so wet that they would flow readily.

The mortar blocks were made of 1 part cement and 2 parts sand, and the concrete blocks of 1 part cement, 2 parts sand and 3½ parts gravel or crushed stone. All measurements were by weight.

The blocks were kept under wet sacks for one week and after this period they were sprinkled with water once a week. The blocks were all tested in the rattler at the age of approximately 90 days, after they had been air dried for one week.

The rattler used was a standard paving brick rattler as recommended by the National Paving Brick Manufacturers' Association, rotated at the rate of 30 revolutions per minute.

Ten blocks were taken for each test and a standard charge of 300 pounds of cast iron shot used. In order to follow closely the effect of this abrasion test, all the blocks were submitted to repeated rattler tests of 900 revolutions each. Ten paving bricks, representing five brands of blocks used on State Aid roads in Illinois, were submitted to a similar test. Each block was marked in such a way that it could be identified during the entire experiment.

Results of Tests.

The neat cement blocks chipped so badly in the rattler that they could not be identified at the end of 900 revolutions. The average loss of these blocks was 42.9 per cent. It should be noted, however, that this loss was due mainly to chipping and not to actual wear of the surfaces, as some of the blocks when taken out of the rattler were showing practically no wear on some of the faces.

The results of the rattler tests on the mortar blocks, concrete blocks and paving bricks are shown in Tables 1 and 2 respectively. Crushed stone was used as the coarse aggregate in the concrete blocks marked 1 to 5, inclusive, while gravel was used as the coarse aggregate in the concrete blocks marked 6 to 10, inclusive.

TABLE NO. 1.

Showing losses of blocks in per cent by weight in last 900 revolutions:

Revolutions of Rattler	900	1800	2700	3600
Mortar Block No. 1	22.0	22.8	22.0	24.8
Mortar Block No. 2	22.6	21.8	21.0	24.4
Mortar Block No. 3	23.0	23.8	22.1	26.7
Mortar Block No. 4	23.1	23.2	22.2	26.3
Mortar Block, No. 5	24.2	24.4	23.1	28.0
Mortar Block No. 6	21.2	21.1	20.0	22.9
Mortar Block No. 7	20.6	21.1	19.9	23.4
Mortar Block No. 8	22.8	24.3	23.0	26.6
Mortar Block No. 9	25.5	26.8	25.6	31.6
Mortar Block No. 10	27.0	28.6	28.4	34.5
Average per cent loss of mortar blocks	23.2	23.8	22.7	26.9
Concrete Block No. 1	34.4	30.2	55.4	
Concrete Block No. 2	34.3	31.7	40.8	
Concrete Block No. 3	39.5	37.2	39.2	
Concrete Block No. 4	38.1	36.7	45.2	
Concrete Block No. 5	41.3	37.8	15.9	
Concrete Block No. 6	34.5	24.2	23.6	
Concrete Block No. 7	42.9	35.6	broken	
Concrete Block No. 8	32.0	26.0	30.8	
Concrete Block No. 9	36.2	28.3	34.4	
Concrete Block No. 10	32.2	27.3	29.2	
Average per cent loss of concrete blocks	36.6	31.5	34.9	
Average per cent loss of crushed stone concrete blocks, 1 to 5 inclusive	37.5	34.7	39.3	
Average per cent loss of gravel concrete blocks, 6 to 10 inclusive	35.7	28.3	29.5	
Paving Brick D No. 1	12.4	6.1	6.5	7.1
Paving Brick D No. 2	11.8	5.2	4.8	4.3
Paving Brick P No. 3	16.4	9.3	6.8	6.8
Paving Brick P No. 4	15.2	7.8	7.5	4.2
Paving Brick A No. 5	12.1	6.2	6.1	5.1
Paving Brick A No. 6	12.1	11.6	9.3	9.3
Paving Brick S No. 7	11.3	broken		
Paving Brick S No. 8	16.5	5.9	6.7	4.8
Paving Brick B No. 9	16.5	9.0	9.4	10.7
Paving Brick B No. 10	12.3	9.0	5.2	5.2
Average per cent loss of paving bricks	13.7	7.8	6.9	6.4

Note—D No. 1, and D No. 2, Danville Blocks; P No. 3 and P. No. 4, Poston Pavers; A No. 5, and A No. 6, Albion Shale Blocks; S No. 7, and S No. 8, Springfield Blocks; B. No. 9, and B No. 10, Barr Blocks.

FIG. 1. CONDITION OF VARIOUS BLOCKS BEFORE AND AFTER RATTLER TEST, 1,800 REVOLUTIONS.

1, NEAT CEMENT BLOCK; 2, MORTAR BLOCK; 3, GRAVEL CONCRETE BLOCK; 4, CRUSHED STONE CONCRETE BLOCK; 5, PAVING BRICK.

TABLE NO. 2.

Showing total losses in per cent by weight of blocks:

Revolutions of Rattler	900	1800	2700	3600
Mortar Block No. 1	22.0	39.7	53.0	64.7
Mortar Block No. 2	22.6	39.6	52.3	63.9
Mortar Block No. 3	23.0	41.2	54.2	66.5
Mortar Block No. 4	23.1	40.8	54.1	66.2
Mortar Block No. 5	24.2	42.5	55.8	68.3
Mortar Block No. 6	21.2	37.8	50.3	61.7
Mortar Block No. 7	20.2	37.5	49.8	61.7
Mortar Block No. 8	22.8	41.5	55.0	66.9
Mortar Block No. 9	25.5	45.6	59.4	72.3
Mortar Block No. 10	27.0	47.8	62.7	75.5
Average per cent loss of mortar blocks	23.2	41.4	54.7	66.8
Concrete Block No. 1	34.4	54.2	79.5	
Concrete Block No. 2	34.3	55.2	73.5	
Concrete Block No. 3	39.5	61.9	76.9	
Concrete Block No. 4	38.1	60.8	78.5	
Concrete Block No. 5	41.3	63.4	69.2	
Concrete Block No. 6	34.5	50.4	62.0	
Concrete Block No. 7	42.9	63.3	broken	
Concrete Block No. 8	32.0	49.7	65.2	
Concrete Block No. 8	32.0	49.7	65.2	
Concrete Block No. 9	36.2	54.2	70.0	
Concrete Block No. 10	32.2	50.7	65.1	
Average per cent loss of concrete blocks	36.5	56.4	71.1	
Average per cent loss of crushed stone concrete blocks 1 to 5 inclusive	37.5	59.1	75.5	
Average per cent loss of gravel concrete blocks 6 to 10 inclusive	35.7	53.7	65.6	
Paving Brick D No. 1	12.4	17.8	23.1	28.5
Paving Brick D No. 2	11.8	16.4	20.5	24.0
Paving Brick P No. 3	16.4	24.2	29.4	34.2
Paving Brick P No. 4	15.2	21.8	27.6	30.7
Paving Brick A No. 5	12.1	17.6	22.6	26.6
Paving Brick A No. 6	12.1	22.2	29.7	36.1
Paving Brick S No. 7	11.3	broken		
Paving Brick S No. 8	16.5	21.4	26.7	30.3
Paving Brick B No. 9	16.5	24.1	31.2	38.6
Paving Brick B No. 10	12.3	20.2	24.7	28.3
Average per cent loss of paving bricks	13.7	20.6	26.2	30.8

Note—D No. 1, and D No. 2 ,Danville Blocks; P No. 3, and P No. 4, Poston Pavers; A No. 5, and A No. 6, Albion Shale Blocks; S No. 7, and S No. 8, Springfield Blocks; B No. 9 and B No. 10, Barr Blocks.

When a block broke in the rattler, the weighing of the pieces was not undertaken, but they were retained in the charge. The condition of the various blocks, after 1,800 revolutions in the rattler, is illustrated in Fig. 1 and Fig. 2. The samples of these blocks are numbered in the following order on all the photographs:

1, Neat cement block; 2, Mortar block; 3, Gravel concrete block; 4, Crushed stone concrete block; 5, Paving brick.

The mortar blocks wore very uniformly, as shown in Tables 1 and 2. This is illustrated somewhat better by Fig. 3, which shows the mortar blocks after they had been submitted to 3,600 revolutions of the rattler.

The gravel concrete blocks show a somewhat more irregular surface than the crushed stone concrete blocks. The mortar

FIG. 2. ABOVE: CEMENT MORTAR AND CONCRETE BLOCKS. BELOW: BRICK BLOCKS, NUMBERS SAME AS FOR FIG. 1.

FIG. 3. MORTAR BLOCKS AFTER RATTLER TEST, 3,600 REVOLUTIONS.

blocks were, however, by far the best blocks tested, outside of the bricks. While their loss in the rattler was larger than that of the paving bricks, they remained more uniworm in size and appearance and did not tend to break and chip like the paving bricks. These qualities of the mortar blocks were checked by rattling a second charge of ten blocks, a sample of which is shown in Fig. 1. None of these blocks broke in the rattler or showed any signs of chipping. The comparative wearing qualities of the paving bricks and various kinds of blocks are well illustrated by the curves of Fig. 5 and Fig. 6.

Conclusions.

While no definite conclusions can be drawn from these tests as to the relative wearing qualities of brick and concrete, yet the results obtained appear to bring out the following facts which have a bearing on concrete road construction:

1. The advisability of using rather small aggregates in one-course concrete road construction. This will tend to insure more uniform wear and a smoother surface.

2. The apparent advantage as far as wearing qualities are concerned, of the two-course method in concrete road construction. A rich mortar or fine aggregate concrete could thus be used for the surface course, insuring much better wearing qualities. At the same time, a lean concrete, or aggregates of rather poor quality, could be used for the lower course and the resulting cost of the road would probably be less than the cost of the one-course concrete pavement, as built at the present time.

3. The disadvantage of using a very wet concrete or of excessive floating of the concrete, both of which have the effect of bringing to the surface of the road a layer of neat cement. The above tests show that neat cement will not stand impact and will rapidly be worn off under traffic. It seems probable that some of the depressions which form on concrete pavements are due to the wearing of neat cement as well as to the formation of stone pockets.

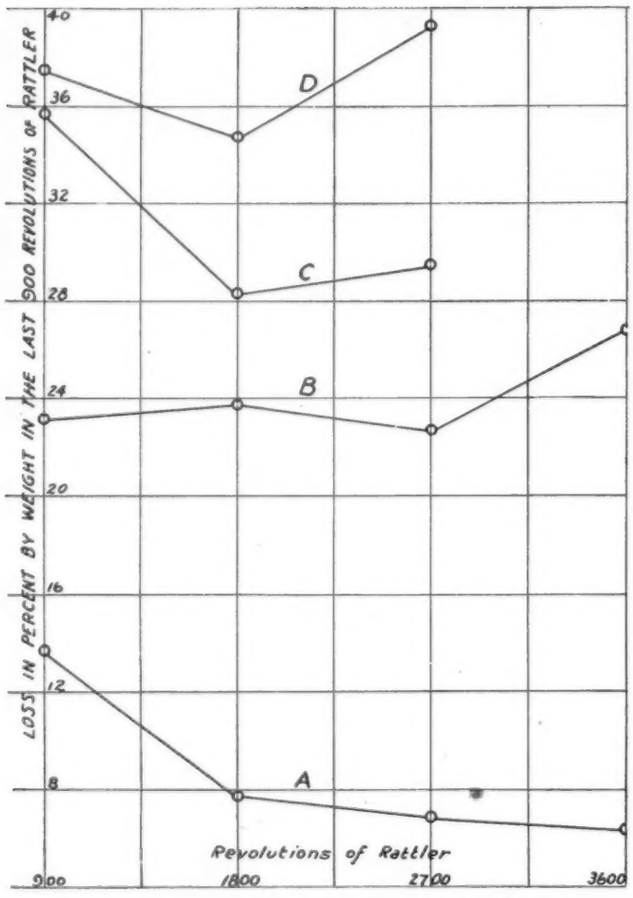
Materials.

The following materials were used in the tests described:

Cement—The same cement was used in all the blocks. It consisted of a portland cement of good quality, meeting the requirements of the specifications of the American Society for Testing Materials and showing the following analysis:

Specific Gravity	3.16
Fineness:	
Retained on No. 100 sieve	4.5%
Retained on No. 200 sieve	23.3%
Time of Setting (Vicat Needle):	
Initial Set	4 hrs. 30 min.
Final set	7 hrs.
Water required for paste of normal consistency	23%
Soundness Tests:	
Accelerated Test	good
Normal Test	good
Tensile Strength:	
24 hr. neat briquettes	305 lbs.
7 day neat briquettes	703 lbs.
28 day neat briquettes	834 lbs.
7 day sand briquettes	317 lbs.
28 day sand briquettes	367 lbs.
Chemical Tests:	
Sulphuric anhydride	1.48%
Loss on ignition	2.00%
Insoluble residue	0.20%

Sand—The same sand was used for the mortar blocks and the concrete blocks. It consisted of a material representing approximately the average sand used for concrete roads in Illinois. The fine sand passing the 1/20-inch sieve consisted largely of quartz, while the coarse grains from ¼ to 1/20 were mainly limestone and trap rock with a small per cent of soft materials, such as ochre, slate, etc. The results of tests of this sand were the following:



CURVES SHOWING TOTAL LOSS IN PER CENT BY WEIGHT OF PAVING BRICKS, MORTAR BLOCKS AND CONCRETE BLOCKS SUBMITTED TO REPEATED RATTLER TESTS OF 900 REVOLUTIONS.

A—Average loss of five brands of paving bricks.
B—Average loss of 1-2 *mortar blocks.*
C—Average loss of 1-2-3½ *gravel concrete blocks.*
D—Average loss of 1-2-3½ *crushed stone concrete blocks.*

Sieve Analysis:

Passing 1/4 -in. sieve	97%
Passing 1/8 -in. sieve	83%
Passing 1/10 -in. sieve	77%
Passing 1/16 -in. sieve	62%
Passing 1/20 -in. sieve	54%
Passing 1/30 -in. sieve	27%
Passing 1/40 -in. sieve	14%
Passing 1/50 -in. sieve	4%
Passing 1/100-in. sieve	2%
Clay in Sand	1.2%
Wearing Test: Per cent of wear	3.4

Tensile Strength:

7 day, 1-3 mortar.....116% of Standard Ottawa Sand
28 day, 1-3 mortar.....119% of Standard Ottawa Sand
90 day, 1-3 mortar.....129% of Standard Ottawa Sand

Crushed Stone—The crushed stone used in the concrete blocks No. 1 to No. 5, inclusive, represents approximately the average stone available for concrete roads in Illinois. It was graded as follows:

Passing 1½-in. sieve	100%
Passing 1¼-in. sieve	97%
Passing 1 -in. sieve	74%
Passing ¾-in. sieve	56%
Passing ½-in. sieve	27%
Passing ¼-in. sieve	2%

The physical tests of the average rock in the quarry from which the above crushed stone was obtained, are given below:

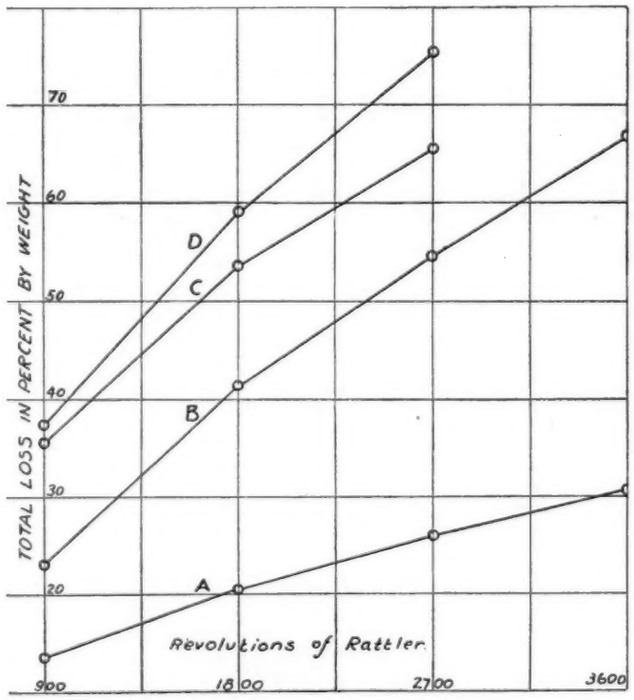
Specific gravity	2.65
Weight per cu. ft.	165 lbs.
Water absorbed per cu. ft.	2.33 lbs.
Per cent of wear	4.7
French coefficient of wear	8.5
Toughness	7

Gravel—The gravel used in the concrete blocks No. 6 to No. 10, inclusive, was a mixed product consisting mainly of limestone, trap and chert, with a very small per cent of ochre, slate and other soft pebbles. Its granulometric analysis and per cent of wear were as follows:

Sieve Analysis:

Passing 1½-in. sieve	100%
Passing 1¼-in. sieve	86%
Passing 1 -in. sieve	82%
Passing ¾-in. sieve	64%
Passing ½-in. sieve	32%
Passing ¼-in. sieve	0%
Wearing Test: Per cent of wear	3.60

Paving Bricks—The paving bricks used in these tests represent five different brands of standard size pavers of the same quality as used on State Aid roads in Illinois during the past two years.



CURVES SHOWING LOSSES IN PER CENT BY WEIGHT IN THE LAST 900 REVOLUTIONS OF RATTLER TEST OF PAVING BRICKS, MORTAR BLOCKS AND CONCRETE BLOCKS.

A—Average of five brands of paving bricks.
B—Average of 1-2 *mortar blocks.*
C—Average of 1-2-3½ *gravel concrete blocks.*
D—Average of 1-2-3½ *crushed stone concrete blocks.*

LEGAL DECISIONS

The Nashville Receivership Case Will Not Longer Delay Paving

For many months the municipal affairs of Nashville, Tenn., have been in very unsettled condition, due primarily to a suit brought against the city and its board of commissioners by R. M. Burns, who had been suspended by the commission from his position in the financial department of the city.

He obtained a temporary injunction against his discharge.

This suit was followed by another brought by a number of taxpayers against the city, the commissioners, contractors, corporations and individuals, finally aggregating about fifty parties. This case is still in progress, the complainants not having completed their testimony, tho the record already exceeds 8,000 pages.

As a result of this suit, some of the commissioners have been ousted and four of the five present commissioners are new members of the board, one having been reinstated, two having been appointed to fill the unexpired terms of persons ousted or resigned and two having been elected at the beginning of regular terms of office.

The lower court ordered the city placed in the hands of a receiver, but this order was reversed by the higher court before it could be put into effect.

Injunctions were issued prohibiting the payment of any money on any existing contracts, especially on paving contracts, so that work in the city has been suspended for about a year. These injunctions were dissolved several months after they were issued or were so modified as to permit the contractors to proceed with their work, but immediately notice was served on the board by those interested in the taxpayers' suit that they would hold the members individually liable for any payments on contracts which were later decided by the courts to be invalid or illegal.

The board has been slow to take action under this state of affairs, but has finally decided to follow its advisers and permit work to proceed and on July 8 signed the necessary agreements with two of the largest paving contractors whereby they will proceed with the completion of the contracts which were awarded to them in 1914 and 1915.

The advisers of the commission have been the city attorney, who declared the paving contracts valid when they were let, and special counsel of the new commission, Charles C. Trabue and Thomas H. Malone, Jr., employed at the suggestion of the city attorney to give an independent opinion upon the contracts in the light of their original making and of the subsequent court proceedings. He had the advantage also of the results of the investigations made by an expert engineer, Walter Douglass, of the staff of James Cameron, who had gone over all the details of the contracts, and of the evidence given on both sides in the taxpayers' suit.

The following extracts from special counsel's opinion give the principal points on which their conclusions are based:

So far as we are advised, three grounds of objection to the validity of these contracts on account of fraud have been suggested, namely:

(a) Because of the exclusion of the bid of the West Construction Company; and

(b) Because the Southern Bitulithic Company, the successful bidder, was a subsidiary of the patentee, Warren Bros. Company; and

(c) Because of a combination to stifle competition.

(a) Mr. Douglas(expert engineer employed by the city of Nashville) says: "The bids of the West Construction Company were not regular, in that they did not accept the so-called license agreement clause, which required the successful bidder to pay to .Warren Brothers Company $1.25 per square yard for a sufficient quantity of bitulithic mixture (that is, stone, sand and bitumen) to pave one square yard of bitulithic pavement 2 inches thick, the said mixture to be furnished within three miles of the work."

This West bid was not considered by the commissioners. The city has the right to specify Warren Brothers patented bitulithic mixture; then undoubtedly it was its right and duty to disregard any bid that did not conform to that specification, and it is certain that the West Construction Company's bid did not so conform.

And even if the specification of Warren Brothers' bitulithic was void, this would not let in the West bid, but would invalidate the whole letting. The terms of the bid stated that it would be "necessary to determine what royalty Nashville will be charged," and there is evidence from various sources tending to show that the usual royalty was 25 cents a square yard, so that, on the theory on which the West Construction Company acted in making its bids—and assuming that the Warren Brothers Company would have acceded to this plan—it would seem that there should be added to the West Construction Company's bid the royalty of 25 cents a square yard, which, according to the details in Mr. Douglas' appendix 11, would make the West bid exceed that of the Southern Bitulithic Company. City Engineer Southgate confirmed that in his testimony in the city suit.

The city's specifications incorporated Warren Brothers' patented specifications for the bitulithic wearing surface, the city acquiring the rights to do so under the license agreement. The West Construction Company in its bids ignored this license agreement and proceeded on the assumption that Warren Bros.' patent was invalid. It appears, however, that this Warren Brothers' patent was some years ago sustained by the United States Circuit Court of Appeals for this circuit (opinion by Judge Lurton), in Warren Brothers Company vs. City of Owosso, 166 Fed. 399, 92 C. C. A. 227, a decision which the Supreme Court declined to review on writ of certiorari (214 U. S. 525, 53 L. Ed. 1067), and that decision had been followed in three other Federal cases, namely, Warren Bros. Co. vs. City of Montgomery, 172 Fed. 414; Warren Bros. Co. vs. City of New York, 187 Fed. 831, 109 C. C. A. 591, and Warren Bros. Co. vs. City of Grand Rapids, 216 Fed. 364. We conclude, therefore, that the city commissioners exercised a reasonable prudence in treating the Warren Brothers' patent as established, and in excluding from consideration the West bid, which ignored that patent.

(b) As has been seen, these contracts were awarded to the Southern Bitulithic Company.

This company was, we think, a subsidiary of Warren Brothers Company; certainly the relationships between the two companies were very intimate. If we are right, then the Southern Bitulithic Company, in bidding, had an advantage over other

companies. It may not have had to pay Warren Brothers Company $1.25 a square yard, or it may not have paid anything, the separate identity of the two companies being purely formal and involving a mere matter of bookkeeping.

While the city commissioners had, themselves, by specifying Warren Brothers' bitulithic at $1.25 a square yard, excluded from competition 70 per cent. of the total cost, nevertheless the other 30 per cent. was supposedly open to competition. Practically considered, however, it does not appear that, as respects the bitulithic contracts, the city was damaged by the circumstance that we are now considering. The unfairness consisted in the opportunity of Warren Brothers Company or its subsidiary to underbid other competitors, not to overbid them.

The only real interest that the city would have in awarding the 30 per cent. would be to see that the cost was not excessive, and Mr. Douglas expresses the opinion that it was not.

The vital question is whether the city had the power to award 70 per cent. of the cost of the contracts in advance of the bidding.

The rule is that fraud, to be relieved against, must be operative and injurious to the party (Wayerbury vs. Netherland, 6 Heisk. 526), and that fraud without damage, or damage without fraud, gives no cause of action. (Flippen vs. Knaffle, 2 Tenn., ch. 240; Rogers vs. Dibrell, 6 Lea. 77, and see also Chamberlain vs. Coal Company, 92 Tenn. 13.) It has been seen that the 30 per cent. was awarded at a reasonable figure, so that if there was any fraud here, the city was not damaged thereby.

It has been seen that the specifications for these bitulithic contracts for 1914 and 1915 prescribed a patented material, namely, Warren Brothers bitulithic wearing surface, and provided that the successful bidder must pay Warren Brothers' Company therefor the sum of $1.25 per square yard; and it has likewise been seen that this sum of $1.25 a square yard to be paid to Warren Brothers' Company in any event constituted 70 per cent. of the total cost, leaving only 30 per cent. open to competition.

The question as to whether a municipality can specify a patented material under a charter which expressly or impliedly provides for competitive bidding is one which has often been before the courts, and one about which there is a decided conflict of authorities. The argument in favor of allowing municipalities to specify patented articles proceeds on the theory that it is to the interest of the city and of all its inhabitants that the best materials and methods of construction, whether patented or unpatented, should be followed. The discussion of this question might be extended to great length by a review of the cases, but this seems to be unnecessary, inasmuch as they are collected and reviewed in elaborate notes in 18 L. R. A. 44, 5 L. R. A. (n. s.) 780, and 46 L. R. A. (n. s.) 990. The author of the latest of these notes sums up his conclusions as follows (46 L. R. A. (n. s.) 992): "The majority of the late cases considering the question with reference to paving contracts, however, sustain the right to stipulate for a particular kind of paving material which is controlled by a patent, where the owner of the patent files with the municipality an agreement to furnish the material to a successful bidder at a stipulated price, altho by a statute such contracts are required to be let upon competitive bidding."

Upon a careful consideration of this whole matter we are of opinion that, while the question is not all free from doubt, the weight of authority and of reason supports the view that city officials, in the exercise of an honest judgment, may specify a patented article or material, notwithstanding the provision in its charter that contracts shall be awarded to the lowest responsible bidder, and that, therefore, these bitulithic contracts were not illegal for this reason.

It has been seen that probably there was no excessiveness in the cost of the 30 per cent. which was left open to bidding, so that, if the cost was excessive, the excessiveness was in the price of $1.25 a square yard fixed in the license agreement. There is nothing to indicate that the city officials were induced by fraud to adopt bitulithic as a paving material or to consent to the price of $1.25 a square yard, so that the question here resolves itself into this: Does the fact that city officials, in entering into a contract that is unaffected by fraud, exercise a bad judgment and agree to pay the contractor an unreasonable and excessive price afford a legal ground for avoiding the contract?

We conclude on this point that these bitulithic contracts cannot be avoided for the sole reason that the price contracted to be paid was excessive, unless the excessiveness was so gross and unconscionable as to impute fraud.

The city contracted to pay $1.45 a square yard for the bitulithic wearing surface. Was that price excessive, and, if so, was it grossly excessive? We have heretofore seen that the excessiveness, if any, was in the license agreement of $1.25 a yard, so that the question really is whether that license price was excessive.

In the first place, what does excessiveness mean in this connection? Does it mean in excess of the market price, as determined by what other cities paid? Or does it mean in excess of the cost plus a reasonable profit? If the particular price was substantially greater than the market price it would be excessive, otherwise not.

The freedom of individuals and corporations to contract is highly regarded by the courts. In the absence of some such circumstances as fraud or a fiduciary relationship the courts will not interfere. A person may legally sell his wares or services for whatever another will pay for them; and a patentee may do this with the added and legitimate advantage that he enjoys a monopoly.

We have no reason to doubt the validity of the Warren Brothers' patent on this bitulithic paving. Also, the information we have is that this bitulithic paving is good paving for municipal purposes. Mr. Douglas, in his report, says: "We must admit that the Warren Brothers' patents are probably valid, that the pavements they have laid in Nashville are excellent, that they are masters of art of such construction, and that it is difficult to get contractors who have knowledge of the art approximately equal to theirs."

There is exhibited with Mr. Douglas' report a statement (Appendix 11) purporting to show the license agreement prices in some 370 contracts entered into with 200 or more cities or towns. Most of these contracts are shown to have been made in 1912, 1913 and 1914, but a good many were made before 1912. Of the prices fixed in these 370 license agreements none was lower than $1.25, the price fixed in the Nashville agreements. Only 21, 5.7 per cent., of the 370 were as low as $1.25, and of these 7 were made with Nashville. All of the 349 license agreements in the list that were at a higher price than $1.25 were made with other cities. They averaged from $1.30 to $1.45, but a good many were in excess of the latter figure.

It even seems doubtful whether the Nashville price could be shown to be unreasonable from an absolute standpoint, for, while it may be an easy matter to ascertain the cost of the labor and materials, and to add to that a reasonable profit, something more must be added to represent the worth of the patent, and this last item is one about which opinions may differ widely. Yet this difficulty must be overcome before any one can say that the price is unreasonable. The worth of a patent in the sense spoken of is largely a matter of opinion; and it may be suggested with some force that the price that the public is willing to pay is the best evidence of its worth.

In the same report above referred to Mr. Douglas says: "I want you to realize that the Warren Brothers' Company will be able to get a great many men of good reputation who will agree with them as to the fact that the bitulithic is worth the price paid by Nashville for it."

We conclude that these bitulithic contracts cannot successfully be impeached on the ground of excessiveness of price.

The contractors have their grievances due to the delay in completing their work, which has caused them much extra expense, due not only to the ordinary expenses of delays, but also to the sharp increases in cost of materials and in wages since these contracts were signed. They had brought suits against the city for damages on account of these delays. The agreements with the two contractors referred to, the Southern Bitulithic Co., and the Foy-Proctor Co., cover the points on both sides.

The companies withdrew their suits against the city; the city agreed to pay the costs in the same up to dismissal; the city pays the companies the amounts due for work already done on contracts, and the companies waive claims to interest on such payments for the time they have been delayed; the companies agree to complete their contracts as promptly as possible and the city to pay for the work according to contract. The companies do not relinquish any rights to bring suits for damages against persons or corporations responsible for the delays producing the damages.

Four of the commissioners signed the agreements, Mayor Ewing and Commissioners Elliott, Stainback and Tompkins, but Commissioner Treanor refused to sign, claiming that his legal adviser considered the contracts invalid. He will do nothing to prevent the execution of the agreements, however.

The amount to be paid the Southern Bitulithic Company when the work is completed is $84,820.88 and the Foy-Proctor Co., $153,633.45.

The city has one peculiar problem on its hands in that it is paying interest on the bonds issued to pay for this paving at the rate of 5 per cent and is receiving 3 per cent on the money on deposit in the banks, so that it has been losing 2 per cent a year on its capital. The bonds are serial bonds and some of them come due before the pavements are completed and paid for, so that the board is obliged in some way to provide the fund to retire the bonds immediately coming due, and pay the difference in interest, as it must now use the money raised by the bond issue to pay the amounts coming due on the contracts, and the assessments for paying the bonds cannot yet be made.

Decisions of the Higher Courts of Interest to Municipalities

Ashland Need Not Purchase Water Works.—By original contract, Ashland, Ky., could elect to purchase water works from company at expiration of franchise for an arbitrated price. Under provision of state Constitution, adopted later, people voted $175,000 bonds for the purchase, but the arbitration board, appointed under mutual agreement to make the transfer, fixed value at $276,000. *Held*, that the constitutional provision did not impair the obligation of the contract between the city and defendant's predecessors, in violation of the federal Constitution, since the contract imposed on the city no obligation to defendant and its predecessors to exercise the option of privilege of purchase thereby conferred, and the Constitution in no way affected the obligation resting on the city of permitting defendant and its predecessors to exercise the rights granted, and hence such option to purchase could only be exercised in accordance with such section. A favorable vote by the voters of a city on the question of incurring an indebtedness in a sum not exceeding $175,000 for the purpose of purchasing and acquiring the rights, property and franchise of a water works system did not authorize the city to incur an indebtedness of over $276,000 for such purpose. Ashland Water Works Co. v. City of Ashland (Ky.) et al., 230 Fed., 254.

Damages for Delay in Completing Contract.—A contract for the construction for a city of a bridge, which provides that the bridge shall be completed within 150 working days, and which stipulates that the contractor, for delay beyond the time specified, shall forfeit to the city, as liquidated damages, $25 a day, and which authorizes the harbor engineer to determine the amount, quality and acceptability of the work, and all questions in relation thereto, and the performance thereof, and decide every question which may arise as to the fulfillment of the contract, and which declares that his decision shall be final, permits the city to rely on the benefit of the stipulation for liquidated damages for delay, tho the work has been unnecessarily or unreasonably delayed by the city or its agents or by others, as provided for in the contract, but the contractor is entitled to credit for such delays in arriving at the number of working days the work extended beyond the 150-day period. Mayor and City Council of Baltimore (Md.) v. Ault et al., 94 Atl., 1044.

Binghamton Water Commissioners Legislated out of Office.—The city of Binghamton was incorporated by Laws 1867, c. 291. The Water Act (Laws 1867, c. 780), enacted to enable the city to supply itself with water, while not enumerating the water department in the list of departments created by the charter, by its provisions as to the duties and powers of the water commissioners closely related it to the city government, so as to make it in effect a city department. The Second Class Cities Law (Consol. Laws, c. 53) applicable to Binghamton on January 1, 1916, without specifically repealing the Water Act or its amendments, by section 252 repealed all ordinances of the city, so far as inconsistent with the chapter and provided by section 94 that, if the city owned and operated water works, the commissioner of public works should appoint a superintendent to hold office during his pleasure and to manage the city's water works under the direction of the commission. *Held*, in an action against the treasurer of the water commissioners and the commissioner of public works to restrain their interference with plaintiffs as water commissioners, that the water works was in fact a city department, and that the Water Act, as amended by Laws 1906, c. 588, was inconsistent with the Second Class Cities Law, and hence was impliedly repealed thereby. Water Com'rs of Binghamton (N. Y.) v. City of Binghamton et al., 158 N. Y. Supp. 888.

Official Index to State Legislation

The "Official Index to State Legislation," for 1915, published in co-operation with the state legislative reference departments and libraries represented in the National Association of State Libraries and the American Association of Law Libraries, and under the direction of the joint committee on national legislative information service of those associations, has been issued. It furnishes a ready reference to all state legislation, and is corrected and cumulated weekly to include all changes in position and new bills introduced during the week. The arrangement of the subject index is (a) by subjects, (b) by states, (c) under each state, the Senate first and then the Assembly or House, and (d) the bills first, and then the resolutions, by introduction numbers. Each entry for each bill and resolution gives (1) the bill number, (2) the date of introduction, (3) the name of the member introducing the bill, (4) the subject, (5) the effect of the proposed legislation or the "short title" of the bill, and (6) the position or status of the bill, on the date shown at the head of the column. In 1916, until June 1, the index will be cumulated and published weekly, with insertion of changes in position of bills and new bills introduced subsequent to the previous issue. The subscription to all the weekly numbers, and the annual number and supplements, for 1916, will be $100, and subscribers for 1916 will be furnished the final 1915 number for $10 additional. Law Reporting Co., 74 Broadway, New York.

City Planning for Somerville

Somerville, Mass., has a planning board of seven members, established by ordinance under an act of the legislature of 1913. It seems to have very little money, $100 serving for expenses for three months or more, and to have no powers except of recommendation to the city council. Five of the seven members serving in 1915 were new to the work. The board recommends a thoro social and economic survey of the city, with complete maps of physical facts prepared by the city engineer. They propose to consider, in developing their work, an increase in industrial establishments and their location in the east and northeast parts of the city; better development of the congested portions of the city, the population per square mile in the city being more dense than in Boston or most large cities in the country; developing retail store districts, to which shopping facilities will be restricted and in which social and civic centers will be established; transportation to Boston and across town, to utilize the new rapid transit lines; recreation grounds and connections between them and the Metropolitan Park system. The board recommends that it be reduced to five members, one appointed each year, so that it will have a more permanent character than is possible under the present ordinance.

FIRE DEPARTMENT

New Developments in Fire Apparatus

The Locomobile Company recently delivered an auto patrol to the Bridgeport, Conn., police department.

The body is mounted on a 48 chassis and is finished in Locomobile green, with the words "Police Department," in gold, standing out in strong contrast with the dark background.

The motor is a Locomobile standard 6-cylinder model M, capable of developing a speed of at least fifty miles per hour.

Entrance is effected at the rear of the car by means of a wide step and two brass rails. There are no doors at this entrance.

The interior of the car is 5½x10x6 feet high, enabling an average man to stand upright in it. Large cushions, upholstered in genuine black leather, run lengthwise of the car, affording seating accommodations for twelve persons. A dome light, such as is used in the most up-to-date limousines, is located in the center of the roof.

The car is equipped with an electric starting and lighting system, extra large wind shield, special dirigible searchlight, and is considered one of the most handsome jobs of its kind ever turned out by the Locomobile Company.

Low Upkeep at Winthrop, Mass.

It cost the town of Winthrop, Mass., just $26.93 to operate a Kelly fire truck for one year. Following is an itemized table showing just how this money was spent:

Gasoline, 79 gallons at 25c	$19.75
Oil, 4 gallons, 2½ quarts, at 45c	2.08
Grease, 1 pound	.20
Dry batteries, 10 at 19c	1.90
Presto tank	3.00
	$26.93

Middletown's New Tractor.

On April 27, 1916, Middletown's new Federal tractor went into service. Under the able leadership of Fire Chief Pitt this department has progressed very rapidly, and to-day the taxpayers are probably assured of a greater measure of protection for each dollar of taxes paid toward investment and maintenance than any other city of equal size in the world.

Middletown is fortunate in having Chief Pitt serve them in his present capacity, for he brings to bear an experience that has been gained over a longer period than that of any other chief in the state. The purchase of the tractor was made in view of the splendid work done by Federal combination No. 3113, which cost for gasoline only $5.07 for the first four months of 1916. During this time the equipment was closely watched and its speed and dependability, especially when running the steepest hills, instilled such a measure of confidence in the people that they eagerly took up Chief Pitt's recommendation for another Federal fire fighter.

Considering that this department lays claim to the distinction of being the first in the state to motorize, we are glad to learn that their continued use of Federal equipment proves conclusively the economy of Federal substitution for the good old faithful horse. Taxpayers are certainly enthusiastic over the chief who can give additional protection at less cost, and this is what Chief Pitt has done for Middletown and what others are doing in all parts of the country. For he has proved that motor equipment will pay for itself in two or three years, one-half of which comes back immediately on the sale of the horses. Curiously enough, it also makes another fireman available for service in time of need, for the Federal tractor at a fire stands without an attendant.

Motor Trucks and Pumps in Fire Departments

The Lent Motor Pumping Engine.

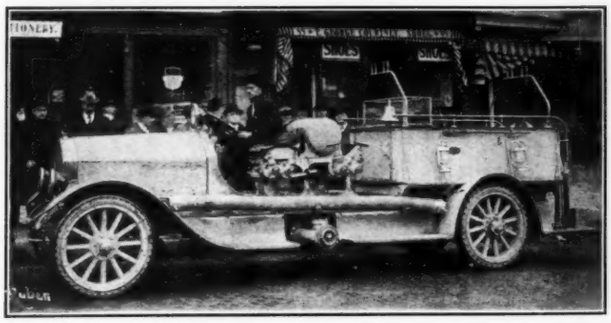
The motor pumping engine described herewith, and built by the Alberger Pump and Condenser Company of New York City, from designs patented by one of their engineers, Mr. L. B. Lent, uses a unique type of centrifugal pump which is direct connected to the gasoline motor. The car is also directly driven through the pump by the use of a conventional transmission, drive shaft and worm-drive axle.

THE PUMP CONNECTION.

A six-cylinder gasoline motor carries the main clutch bolted to its flywheel. Directly behind the clutch shaft, and in line therewith, is the pump, whose shaft is connected to the clutch shaft through a flexible steel coupling. The rear end of the pump shaft is connected to the transmission thru a similar flexible steel coupling, and a pair of universal joints and drive shaft conveys the drive to the worm of the rear axle. It is thus evident that the car is driven in the conventional manner, the drive passing right thru the pump. If the pump casing were removed, the remainder would constitute a standard truck chassis.

The design of the pump discloses a very simple and clever method of meeting the service demands of fire apparatus, which call for a considerable range of pressures and capacities. Specifications usually call for the pump capacity to be delivered against 120 pounds pressure and approximately half of the capacity against 200 to 250 pounds pressure.

The pump shown is built as a pair of two-stage pumps in a common casing. A division wall thru the center divides the two sides. A suction connection is provided on each side



of the car. These connections divide outside the pump and pass water to each side of the pump at the bottom.

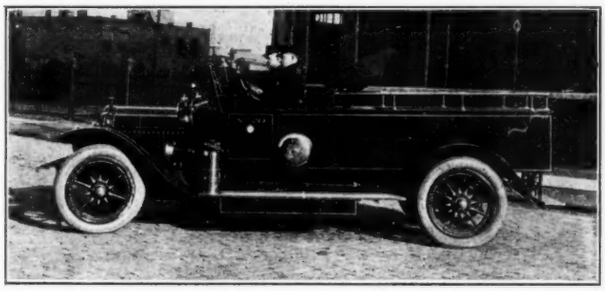
Each side of the pump is capable of delivering its rated capacity (400 gallons) against a discharge pressure of 125 pounds per square inch. Thus when the two sides are running together, or in parallel, the total delivery will be the sum of the deliveries from the two sides, or 800 gallons at 125 pounds pressure. A water passage, cored in the casing, connects the discharge from one side to the suction side of the other side. This passage may be opened or closed by a quarter turn of the plug valve located therein. It is thus possible to easily and quickly deliver the discharge from one side of the pump to the intake of the other. In this case 400 gallons per minute at 125 pounds pressure is delivered to the other side, in which the pressure is increased another 125 pounds, making the actual delivery 400 gallons at 250 pounds pressure. The delivery of water under pressure to the suction side of the pump casing, as described, closes a check valve in the suction line leading to this side, and so prevents water under pressure flowing back into the suction pipe. The whole process of conversion from a pair of two-stage pumps to a single four-stage pump, or vice versa, is accomplished by a quarter turn of the plug valve. In both the conditions described the results are obtained at the same rotative speed, which is obviously the same as the motor speed. By varying the motor speed, a wide range of pressures and capacities is obtained.

The suction connections on both sides of the car are close to the ground and in a handy position for coupling up. Four discharge connections and gates are placed on each side of the car, so that the maximum pump capacity may be taken off from either or both sides. The usual fire equipment is carried and body space is provided for 1,200 feet of 2½-inch hose.

The total weight, with full equipment, but without men or hose, is said to be less than 10,000 pounds.

Gas Emergency Truck

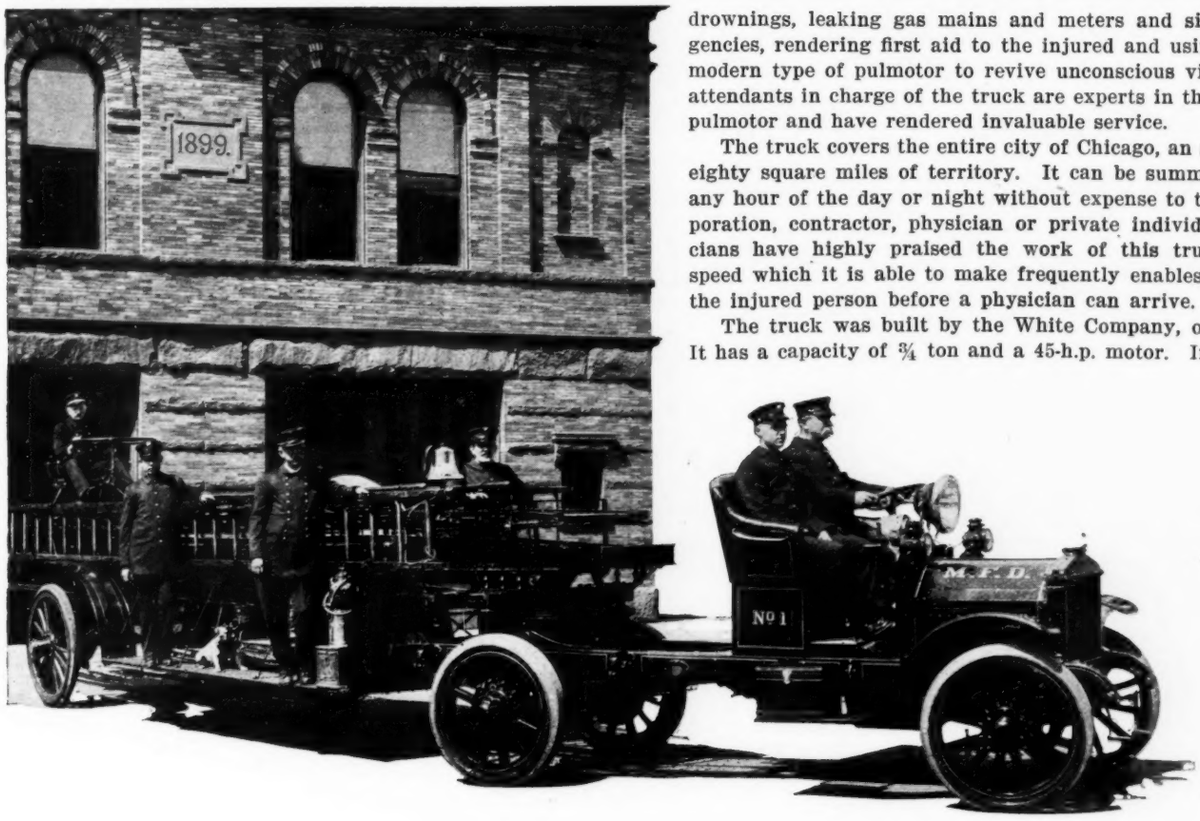
Many lives have been saved and heavy property losses averted in the city of Chicago, since the installation of a new emergency truck by the Peoples' Gas Light and Coke Company. It responds to every big fire alarm, gas leaks, sewer and street cave-ins, accidents to buildings, asphyxiation cases, suicides, drownings, leaking gas mains and meters and similar emergencies, rendering first aid to the injured and using the most modern type of pulmotor to revive unconscious victims. The attendants in charge of the truck are experts in the use of the pulmotor and have rendered invaluable service.



The truck covers the entire city of Chicago, an area of over eighty square miles of territory. It can be summoned out at any hour of the day or night without expense to the city, corporation, contractor, physician or private individual. Physicians have highly praised the work of this truck and the speed which it is able to make frequently enables it to reach the injured person before a physician can arrive.

The truck was built by the White Company, of Cleveland. It has a capacity of ¾ ton and a 45-h.p. motor. In answering

THIS FEDERAL TRACTOR IN COMBINATION WITH MIDDLETOWN'S HOOK AND LADDER GIVES "GREATER PROTECTION AT LESS COST" AND IS THE ENTHUSIASTIC RECOMMENDATION OF THE OLDEST FIRE CHIEF IN CONNECTICUT.



fire calls it is the duty of the attendants to rush into the burning building, turn off the gas or render such other assistance to the injured or entrapped persons as it is possible for them to perform. Before the truck was purchased by the Peoples' Company, firemen were greatly handicapped in discovering gas leaks or locating the shut-off valves. Delays of this kind were very dangerous and frequently gas explosions followed small fires that otherwise could have been averted had the fire-fighters been able to quickly shut off the gas. The emergency men know the exact location of all gas lines, electric light connections, etc., and are able to render quick assistance.

Big Saving at Worcester, Mass.

Name of chief—Wesley N. Avery.
City—Worcester, Mass.

AUTO APPARATUS.

Period of time—From December 1, 1914, to December 1, 1915.
Type of motor fire apparatus—Combination hose and chemical.
Name of make—American-LaFrance.

Cost of repairs, including labor and material	$ 2.81
Cost of gallons of gasoline	22.73
Cost of gallons of oil	4.77
Cost of gallons of grease	.10
Miscellaneous expense	16.41
Total cost	$ 46.82
Distance traveled (miles)	330
Cost per mile	$ .14
Number of alarms answered	151

HORSE-DRAWN APPARATUS.

Period of time—From December 1, 1914, to December 1, 1915.
Type of horse-drawn fire apparatus (same equipment)—Hose wagon.
Name of make—Local builder.

Cost of repairs, including labor and material	$ .50
Cost of feed	330.07
Cost of shoes	72.00
Harness repairs	17.40
Miscellaneous expense	
Total cost	$419.97

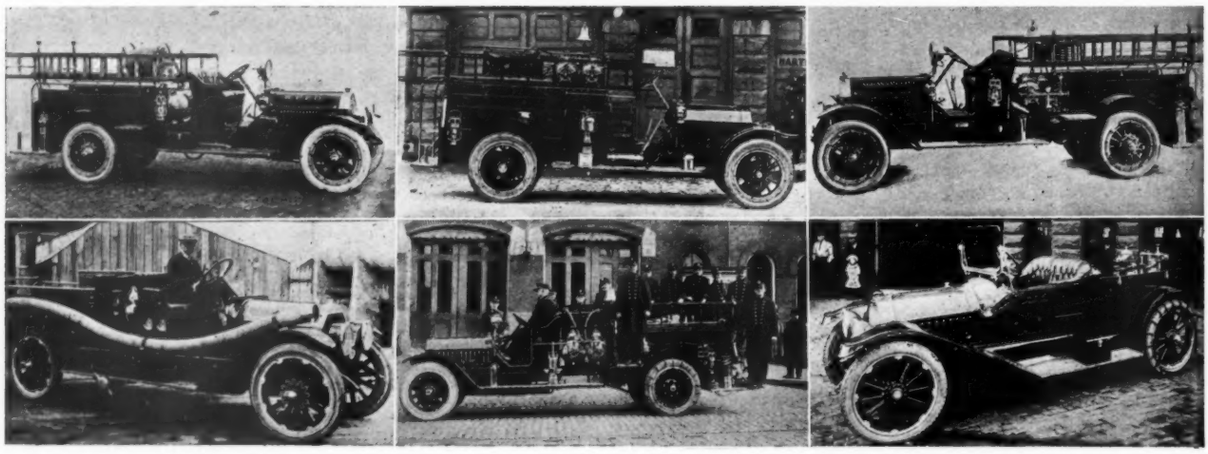
MAXWELL CHIEF'S CAR AS OPERATED BY CITY OF ROSWELL, N. M.

Distance traveled (miles)	310
Cost per mile	$ 1.35
Number of alarms answered	158

UPKEEP ON TWO MOTOR PIECES.

Chief B. H. Barnes, fire department, Olympia, Wash., submits the following costs covering upkeep of one Seagrave combination hose and chemical and White truck for a period of twelve months:

Cost of repairs, including labor and material	$ 10.75
Cost of gallons of gasoline(at 19c)	43.60
Cast of gallons of oil	5.50
Cost of gallons of grease	2.40
Miscellaneous expense	200.00
Total cost	$262.25
Distance traveled (miles)	260
Number of alarms answered	98



KISSEL COMBINATION TRUCKS IN FIRE DEPARTMENTS.

KISSEL 6 CYL., 60 H. P., COMBINATION AND HOSE TRUCK (WITH LADDERS,) CITY OF NORTH PLATTE, NEB.

KISSEL 6 CYL., 60 H. P., COMBINATION PUMPER AND SQUAD WAGON, CITY OF OAKLAND, CAL.

KISSEL 6 CYL., 60 H. P., COMBINATION CHEMICAL AND HOSE TRUCK, CITY OF FALL RIVER, MASS.

KISSEL 4 CYL., 50 H. P., COMBINATION CHEMICAL AND HOSE TRUCK (WITH LADDERS) CITY OF KANKAKEE ILL.

KISSEL 6 CYL., 60 H. P., COMBINATION CHEMICAL AND HOSE TRUCK (WITH LADDERS), ARKANSAS CITY, KANS.

KISSEL 6 CYL., 60 H. P., CHIEF'S CAR, CITY OF DULUTH, MINN.

Average Annual Team Cost.

Chief H. B. Jones, fire department, Amarillo, Tex., states that the average annual cost of a team of fire horses is $888. Chief Jones submits the following cost record covering operation of a motor combination, for the same period:

Cost of repairs, including labor and material	$ 1.18
Cost of gallons of gasoline	55.00
Cost of gallons of oil	25.20
Cost of gallons of grease	1.60
Miscellaneous expense, storage battery	8.17
Total cost	$ 91.51
Distance traveled (miles) (Combination, 265; combination, 231; pump, 151)	647
Cost per mile	$ .14
Number of alarms answered	52

The year's cost of tires and inner tubes for three pieces of motor apparatus, is listed as follows:

Tires, 1-1-15 to 1-1-16	$390.00
Inner tubes, 1-1-15 to 1-1-16	27.00

Annual Cost of Four Teams.

Mr. James P. Welsh, fire chief, Eau Claire, Wis., lists horse maintenance (four teams), for past twelve months, as follows:

778.28 bushels of oats, average cost $0.454	$353.55
30.45 tons of hay, average cost $7.465	227.41
Rolled and ground feed	47.18
6560 pounds straw	13.18
Total cost for forage	$641.32
Cost per horse per year for forage	$80.165
Cost per horse per day for forage	.21 96/100
Veterinary service	$ 12.30
Shoeing (per horse, $13.65)	109.20
Barn supplies	10.85
Total cost	$773.67
Total cost per horse per year	$96.70
Total cost per horse per month	8.058
Total cost per horse per day	.26 49/100

"Our hose and chemical motor car," states Chief Welsh, "during the year covered a distance of 246 miles, at the following cost:

Gasoline consumed amounted to 134 gallons, at a cost of	$14.50
Lubricating oil, 5 gallons	2.00
Oil forage for car (1.37½ per month)	$16.50
Repair costs	34.11
Total for year	$50.61

Maintenance cost per month, $4.22.

"During the year we changed our rear wheels to standard and from block to demountable four-inch dual solids; cost, $188.08.

"In view of the fact that tire deterioration takes place regardless of mileage, I would place a depreciation charge on tires of approximately $3.00 per month. I do not believe it will exceed that figure, and may drop somewhat below that estimate.

"With the prospects favorable for an additional piece of motor apparatus in 1916, and the retiring of two more horses, places us about 40 per cent. motorized."

Oakland, Cal., Comparisons.

Mr. Elliott Whitehead, fire chief, Oakland, Cal., submits the following statement of motor costs as compared with horse-drawn maintenance:

AUTO APPARATUS.

Period of time—From September, 1915, to March, 1916.
Type of motor fire apparatus—Hose and chemical.
Name of make—Seagrave.

Cost of repairs, including labor and material	none
Cost of gallons of gasoline (55 gallons)	$ 5.23
Cost of gallons of oil (4 gallons)	1.20
Cost of gallons of grease	1.10
Miscellaneous expense	3.10
Total cost	$ 10.63
Distance traveled (miles)	90
Number of alarms answered	43

AUTO APPARATUS.

Period of time—From September, 1915, to March, 1916.
Type of motor fire apparatus—Double 80-gallon chemical.
Name of make—American-LaFrance.

Cost of repairs, including labor and material	none
Cost of gallons of gasoline (50 gallons, at 9½c)	$ 4.75
Cost of gallons of oil (4½ gallons, at 30c)	1.45
Cost of gallons of grease	1.85
Miscellaneous expense	3.00
Total cost	$ 11.05
Distance traveled (miles)	37
Number of alarms answered	27

HORSE-DRAWN APPARATUS.

Period of time—From September, 1915, to March, 1916.
Type of horse-drawn fire apparatus (same equipment)—Hose and chemical.
Name of make—Robinson.

Cost of repairs, including labor and material	none
Cost of feed (two horses)	$120.00
Cost of shoes	30.00
Harness repairs	2.60
Miscellaneous expense	3.85
Total cost	$156.45
Distance traveled (miles)	73
Number of alarms answered	45

John Snobarger has been the efficient chief of the fire department of Goshen, Ind., continuously since 1884. The department was reorganized in 1905 on a paid basis, with twenty-one call men and six regular firemen.

Chief Albert Herring, of Murphysboro, Ill., joined the volunteer fire company at sixteen years of age. Fifteen years ago, when the paid company was formed, he was chosen to head it and thus became the youngest fire chief of any paid fire department in Illinois. He is a member of the Illinois Firemen's Association and the International Association of Fire Chiefs.

Concrete Septic Tanks for Farm and Town Dwellings

Recent statistics show that many cities are healthier places in which to live than is the average rural community. The reason for this is that city health authorities enforce regulations compelling the disposal of house wastes in a sanitary manner. Most cities are equipped with sewerage systems and disposal plants where sewage is rendered practically harmless. Small towns and rural communities are not usually so favored. Farmhouse wastes are often thrown out upon the ground in a thoughtless manner, without regard for the possible sickness and death that may result from such practice, not only to persons in the immediate locality, but to others far away. Most epidemics of disease in the city, such as typhoid, scarlet fever and diphtheria, can often be traced to insanitary conditions on the farm, such as contaminated water supplied to dairy stock.

House wastes scattered upon the ground or even discharged into a cesspool, seep thru loose soil and eventually contaminate water supply, which, in turn, passes germs on to dairy stock, then into milk. Cesspools, if located in firm soils, must be pumped out periodically. In such cases the contents are distributed over the surface of the ground, giving forth vile odors, and the filthy wastes are sooner or later washed into some stream, thus polluting it and spreading infection. If the cesspool is located in sandy or gravelly soil, thru which the contents made continually seep out, then sooner or later the source of domestic water supply on the farm, the well, will become contaminated.

Modern conveniences of the city dwelling have been extensively adopted for the farmhouse. The kitchen sink, the bath and indoor toilet are too convenient to do without, yet have a penalty attached unless the wastes that are handled by such a system of house plumbing are disposed of in a satisfactory manner. The cesspool should no longer be tolerated. Instead, a sewage disposal system that will be sanitary, convenient for use, easy to maintain and of simple construction, should be substituted. Such a system is represented in the modern septic tank.

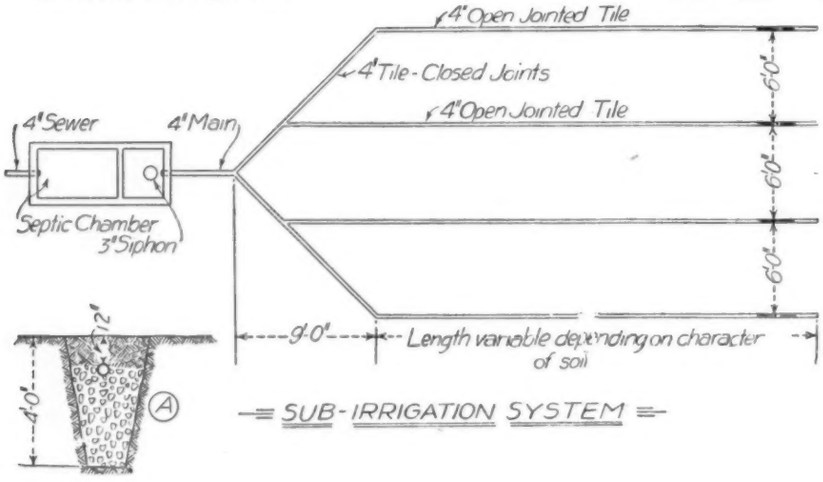
A properly designed septic tank should have not fewer than two compartments. House sewage is discharged into the first of these compartments (sometimes called the sedimentation chamber), where bacteria develop, multiply, and feed on the sewage, so to speak, thus breaking up and changing a portion into relatively harmless compounds. Such processes as occur in this first compartment, however, do not render the sewage entirely harmless. The bacterial process occurring in the first compartment, which must be dark and practically air-tight, represents one of two successive stages necessary for sewage purification. The second, which consists of a combination of oxidization, nitrification and filtration, must be performed in the presence of light or air, or both. The order of purification must always be as indicated, first, the bacterial action; second, aeration and nitrification, never the reverse.

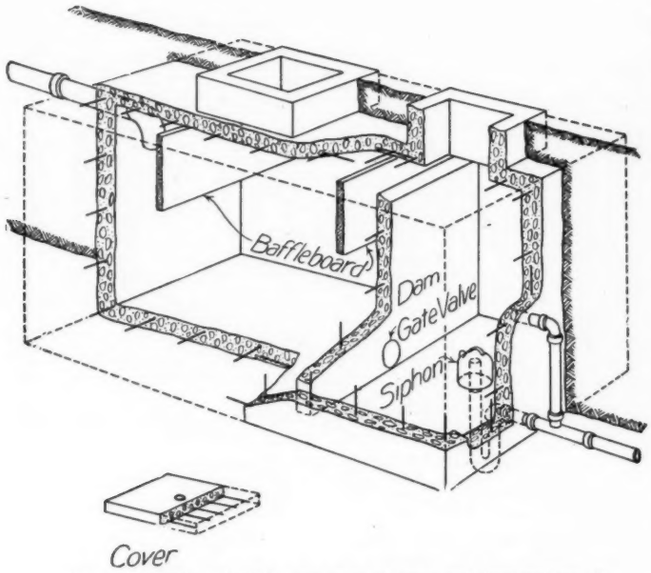
Final disposal may be carried on in either of two ways. Where possible to do so, surface or broad irrigation is satisfactory, which means discharging the sewage from the septic tank upon the land, where it is allowed to spread over the ground and be acted upon by the sun and certain other bacteria which live in the upper layers or portions of the soil. The plat of ground used for this purpose may be cultivated land or may be an area of waste land. In either case it should be located as far as possible from the source of domestic water supply, this distance never being less than 200 feet. Care should be taken to keep dairy cattle from grazing over the disposal area.

Discharges from the tank should be carried to the disposal field by a tile line having sealed joints and emptying into an open ditch about 12 inches wide and 6 inches deep, with laterals at right angles to it and about 6 feet apart, dug with sufficient grade so that the liquids will spread quickly and evenly over the whole area.

Another method of disposal is frequently practiced. This is called sub-surface irriga-

I. PLAN OF SEPTIC TANK *with final disposal system after the sub-irrigation method, showing also a section of trench which may sometimes be necessary when tile are laid in tight soil.*





II. SEPTIC TANK, *for use where sub-irrigation is practiced, showing tank interior partly exposed as if a portion of the tank were cut away.*

tion, and consists of discharging the tank contents into lines of 4-inch drain tile laid with open joints, from which the fluids leach or filter into the soil. The grade of such a tile line should be not greater than 2 or 3 inches per 100 feet.

To prevent soil from entering the tile line thru the open joints, these may be covered with flat stones or pieces of broken tile of larger diameter.

Sub-surface irrigation is in a way similar to broad irrigation, in that the final stage is filtration; the intermediate step, namely, aeration and nitrification, being carried on immediately beneath the surface of the ground instead of on its surface.

Fig. I illustrates the disposal method by sub-irrigation. Lengths of drains necessary will be governed by the nature of the soil. If this is loose and sandy, 200 feet is sufficient, altho in tight soil it may be necessary to double its length.

Generally speaking, the method of disposal by sub-surface irrigation is best adapted to the single residence. This system usually requires less attention to secure satisfactory operation; furthermore, the sewage is entirely hidden from sight after discharged from the tank, and this is a desirable feature.

Sub-surface irrigation is not well adapted to firm or dense soils. In such cases a plan sometimes adopted is illustrated at "A" (Fig. I); that is, the tile are laid on a gravel or cinder filling in trenches, then covered with about a foot of earth. In heavy clay soils an additional line of tile in the lower portion of trench to drain it is frequently necessary.

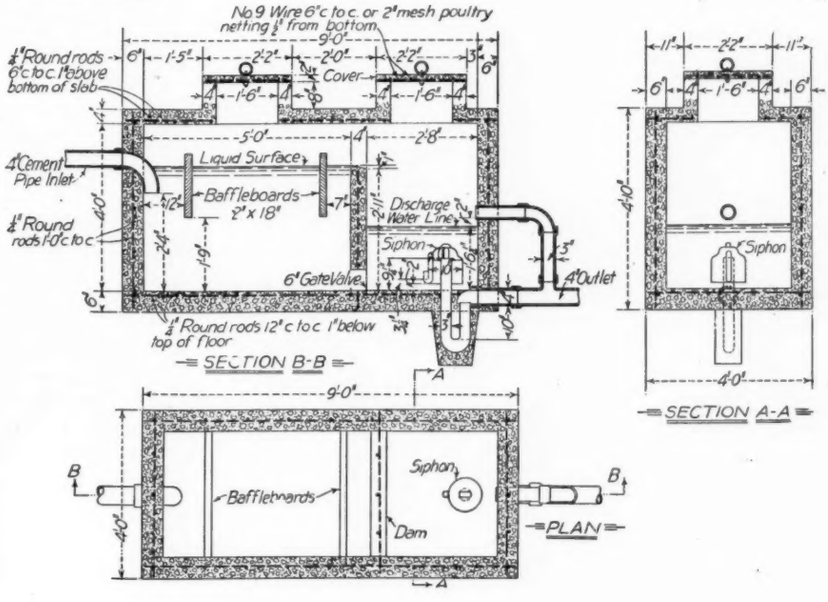
Figs. II and III show sections of a septic tank. This type will be found to operate effectively where final disposal is accomplished by sub-surface irrigation. This system once started is self-operating, due to the intermittent siphon shown in the second, or right-hand compartment, which at regular intervals empties the contents and discharges them into the line of tile, from which the liquids leach out thru joints into the soil. In a tank constructed as shown in the design mentioned, it is very important to use a siphon to empty the second compartment at intervals instead of allowing a continuous outward flow of contents, because of the tendency for drains to become clogged when liquids are constantly trickling thru.

The size of tank required for residence use depends upon the quantity of sewage to be handled in the first chamber during a day of twenty-four hours, therefore, this compartment should be large enough to contain an entire day's flow. This frequently amounts to from 30 to 50 gallons per person per day, so the required capacity can readily be computed from these figures, but it must be remembered that the required depth for the tank should be figured from the top of the concrete baffle wall or partition which separates the first and second compartments. Another point to bear in mind is that the width of the first compartment should be about one-half its length.

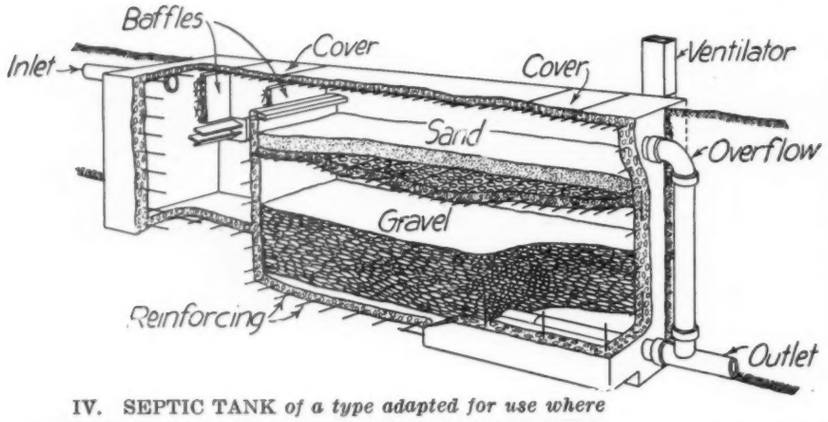
Where broad irrigation is practiced because of dense soil or where the fall of ground does not make the sub-surface irrigation system practicable, then the design shown in Figs. IV and V will be found effective. If the length of the first chamber is 3 feet 9 inches, the tank will accommodate the wastes from a household of six persons, figuring that an average of 50 gallons of sewage per day for each member must be disposed of. If a family of eight is to be served, the length "A" should be made 5 feet. It is estimated that one day will be required for a given amount of liquid to pass thru the first compartment, under the baffle and over the weir or partition wall, upon the sand filter.

In both of the designs presented, it will be noticed that baffle boards are shown. These are for the purpose of preventing any disturbance of the scum which forms on the surface of the liquid in the first compartment, because efficient bacterial action is dependent upon keeping this scum motionless and preventing any of it from being carried out of the compartment. These baffles break up eddies and currents caused by the flow coming into the tank and in the first design consist of two 2 by 18-inch boards set in slots formed in the tank walls at the time concrete is placed.

In the second design concrete baffles are shown, as well as three 1 by 6-inch boards so placed at the inlet side of the first compartment that they will break currents from sewage entering the tank. These boards are secured in position by toenail-



III. PLAN *and two sections of the septic tank shown in Fig. II.*



IV. SEPTIC TANK *of a type adapted for use where final disposal is made by means of broad irrigation. This view shows the construction as tho partly cut away to expose the interior view.*

ing at the ends to small pieces of lumber set into the tank walls when concrete is placed. Both designs show manholes which permit access to the tanks for cleaning, tho the necessity for this is infrequent.

Septic tanks are best constructed of concrete, which should be mixed in the proportions of 1 sack of portland cement to 2 cubic feet of coarse sand graded up to ¼ inch,, to 3 cubic feet of screened gravel or crushed stone, the particles of which vary in size from ¼ to 1½ inches. Enough water should be used to produce a mixture of quaky consistency so that the concrete when placed will settle into all parts of the forms when slightly jogged or puddled with a spade or similar tool. Spading assists in removing air bubbles from the concrete and produces a denser mass. Tank walls should be 6 inches thick, reinforced as shown on the drawings.

In Fig. IV concrete baffle walls extend down from the cover slab a distance of about 1 foot 6 inches. These are reinforced by means of ¼-inch round rods spaced 6 inches center to center, both vertically and horizontally. Between the two chambers there is a weir or dividing wall 4 inches thick extending from the floor to within 6 inches of the cover slab. This wall is provided with a lip so that the sewage cannot trickle down the face of the wall but will at once be discharged upon the sand filter. This lip is reinforced by bending the ends of the vertical reinforcing in the weir wall at right angles to it and by one horizontal rod near the edge.

The sand filter is 6 inches deep and 2½ times the length of the first compartment. It is supported by a 3-inch concrete slab, 35 inches wide, divided into three sections, reinforced with ¼-inch round steel rods, and contains a large number of conical openings. These are made in the slab by setting tapered pieces of wood into the concrete before it has had time to harden. When the slabs are placed, these openings are filled with small pebbles to prevent the sand from passing thru to the gravel filter below. In order to simplify the work of building the filter board, a suggestion for another type is shown at the lower right-hand corner of Fig. V. This board is made of 2-inch lumber with gimlet holes drilled as shown. A 3-inch ledge projecting from the side wall serves as a support. The three sections permit easy removal in case it is desired to secure access to the gravel filter.

To prevent liquids from running along the side walls, two end pieces of the above slab are set into slots, in which clay has previously been daubed to form a tight joint. Clay may be used also to fill the openings between the ends of the slab and the side walls, as the slab is made of lesser width than the chamber, to permit easy removal.

Perforating this slab causes the filtered sewage to be sprinkled upon the coarse gravel filter below, and as it falls, it passes thru an 18-inch air space which is ventilated by means of air shafts at opposite sides of the structure. A difference of at least 8 feet in the height of these air shafts is advised in order to create as much draft in the upper portion of the gravel filter chamber as possible. A ventilator placed upon the taller shaft would assist in this respect.

Gravel in the lower filter should not be smaller than one-half (½) inch and is well cleaned and screened before placing, as it is desirable that the sewage be thoroly aerated as it passes downward toward the tile which drains the plant. Air which enters by means of this tile also serves to supply ventilation to the gravel bed. If it is desired to make use of the gravel filter feature where the natural fall of ground does not permit draining, the perforated slabs can be omitted, raising the floor of the gravel chamber 1 foot 9 inches. The discharge from such a tank can be distributed over the surface of the ground with no fear that odors will cause a nuisance. (It will be seen that the gravel filter in this plant performs the same service as the gravel in the trench "A," Fig. I.)

The size of reinforcing rods, their spacing and location are all shown on the drawing in such a manner that there need be no doubt as to these features of construtcion.

The Universal Portland Cement Co. supplied the plans illustrated, together with the notes detailing construction requirements.

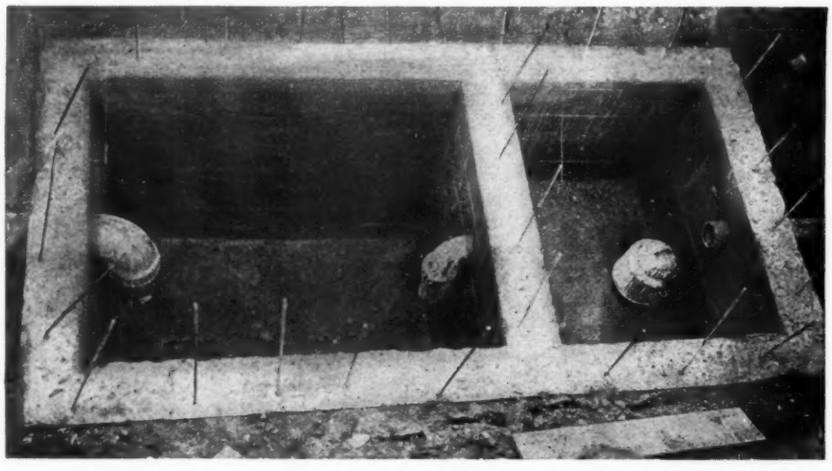
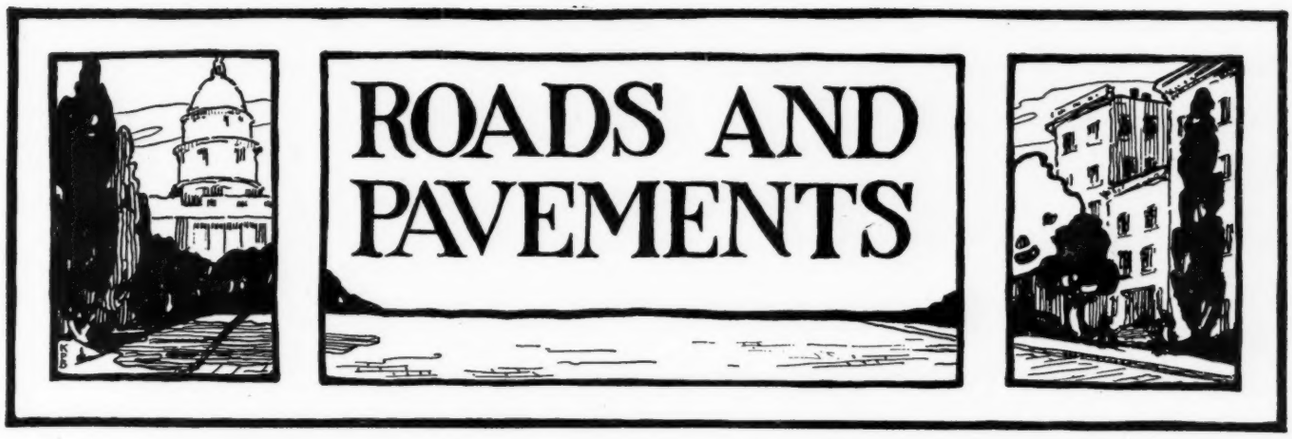


FIG. VI. CONCRETE SEPTIC TANK *similar to the type shown in Fig. II. This shows both compartments as they appear before placing the concrete roof or cover slab. Reinforcing rods from the side walls are bent over to form part of the reinforcing for the cover.*



Fibered Asphalt for Road Surfacing

Fibered asphalt, the use of which on the streets of Charleston, W. Va., was described in MUNICIPAL ENNGINEEBING for May, 1915, has been used for resurfacing some miles of bituminous macadam highways by the State Highway Department of New York to reduce the excessive cost of maintenance of these roads. These roads are reported to be very satisfactory after about one year of use.

In June, 1916, the Iowa Wood Fiber Asphalt Company, of Davenport, used the material for surfacing a telford-macadam road from which the macadam had practically all been worn away and little was left but the large stones of the telford base, the spaces between which were more or less solidly filled with the finer macadam material. The area covered with the fibered asphalt wearing surface is on a rather steep grade, as shown by the photographs, a part of the Davenport-Cadda road and of the Blackhawk Trails, north of Davenport, and a short distance beyond the city limits. Traffic is quite heavy. One hour's count in July showed 60 automobiles, 6 heavy motor trucks, 7 buggies and 8 large dump wagons, hauling stone. On account of the grade, and perhaps the drainage, the section requires much repair and is seldom in as good condition as ae road in general.

I. PART OF BLACKHAWK TRAIL, NORTH OF DAVENPORT, IOWA, TELFORD MACADAM, WITH THE LARGE STONES OF THE FOUNDATION PROJECTING.

The macadam base is 16 ft. wide and on much of the length resurfaced the shoulders had been worn down well below the top of the telford base, so that it was necessary to build them up to serve as shoulders for the new fibered asphalt surface.

The white spots in the photograph of the road before improvement are the projecting large stones of the telford base and indicate the difficulties in the way of securing a uniform thickness of the surfacing material, especially since the crown must be flattened.

It was necessary to remove a few of these stones and to knock the tops off of others, but as little of this was done as possible for the reasons that these stones form the foundation of the road. In a few instances the thickness of the fibered asphalt layer over the top of a stone is less than an inch, but the pavement seems to be quite as durable at these points as elsewhere. When the thickness was found to be less than a half inch the pavement was cut into, the stone removed and the hole filled with the fibered asphalt mixture.

All the dirt and loose stones were removed with pick and shovel, followed by sweeping with stiff brooms. The second photograph shows the removal of this material, which in this particular spot consisted of the remains of some gravel dumped on the road in the maintenance of the old road. Just before laying the asphalt layer, the dust was thoroly swept off the road, as shown in the third photograph.

Any material depressions in the surface, and the holes left when large stones were removed, were filled with the hot fibered asphalt mixture, which was tamped in with hot tampers, as shown in the fourth photograph.

After a final sweeping, the fibered asphalt mixture was spread and rolled in the same manner as an asphalt wearing surface, except that no special edging was required, either along the sides or at the end of a batch, as shown in the fifth photograph. A 10-ton tandem roller was used.

No cushion coat is required under the fibered asphalt wearing surface and it was intended to make the average thickness 1½ in., but the irregularity of the surface and especially the projecting large stones of the telford base, made it necessary to increase this average thickness materially in some places

II. CLEANING OFF THE DIRT AND LOOSE STONE DOWN TO THE SOLID BASE.

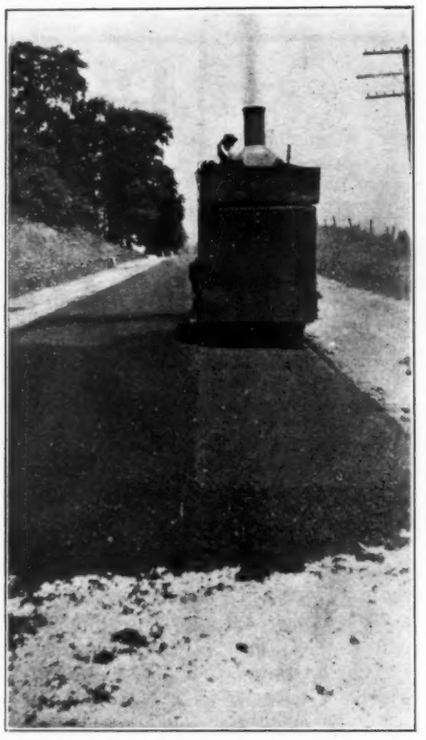
III. FINAL SWEEPING OF THE DUST FROM THE SURFACE READY TO LAY FIBERED ASPHALT COVER.

in addition to filling the deeper holes with tamped material ahead of the laying of the regular course.

The sides of the layer were brought out near the edge of the macadam base to full thickness and were tamped so as to give a slope of about 1 to 1. The effect of this tamping can perhaps be seen in the fifth photograph. The roller was then run out to the edge and caused very little spreading of the material, less, in fact, than was allowed for.

IV. TAMPING FIBERED ASPHALT MIXTURE INTO THE DEEPER DEPRESSIONS IN THE ROAD SURFACE.

VI. THE COMPLETED FIBERED ASPHALT SURFACE ON AN OLD TELFORD-MACADAM BASE.



V. ROLLING THE LAYER OF FIBERED ASPHALT MIXTURE AS SPREAD. NOTE CHARACTER OF TAMPED EDGE ALONG THE SIDES AND THAT ROLLING DOES NOT CAUSE THE ASPHALT TO CREEP IN ANY DIRECTION.

After very thoro rolling, a squeegee coat of asphaltic cement was spread, a thin coating of stone screenings and dust was thrown uniformly over it and another thoro rolling was given the pavement. Before this final rolling, the shoulders of the road were built up with a road grader, some gravel being deposited next to the asphalt, and the shoulders were rolled with the pavement so as to make a uniform surface in the cross-section, including both pavement and shoulders. The contractor learned that it is important to have the shoulders well built up and that the gravel must not be too clean, that the rolling may thoroly compact them and not make the side slopes too steep.

In the last two photographs it will be noted that the crown of the asphalted part of the street is quite flat. This was insised upon by the consulting engineer of the Wood Fiber Asphalt Company, of Charleston, W. Va., under whose patents the pavement was laid, because of the steepness of the longitudinal grade. At the bottom of the hill, on the level, a heavier crown was used.

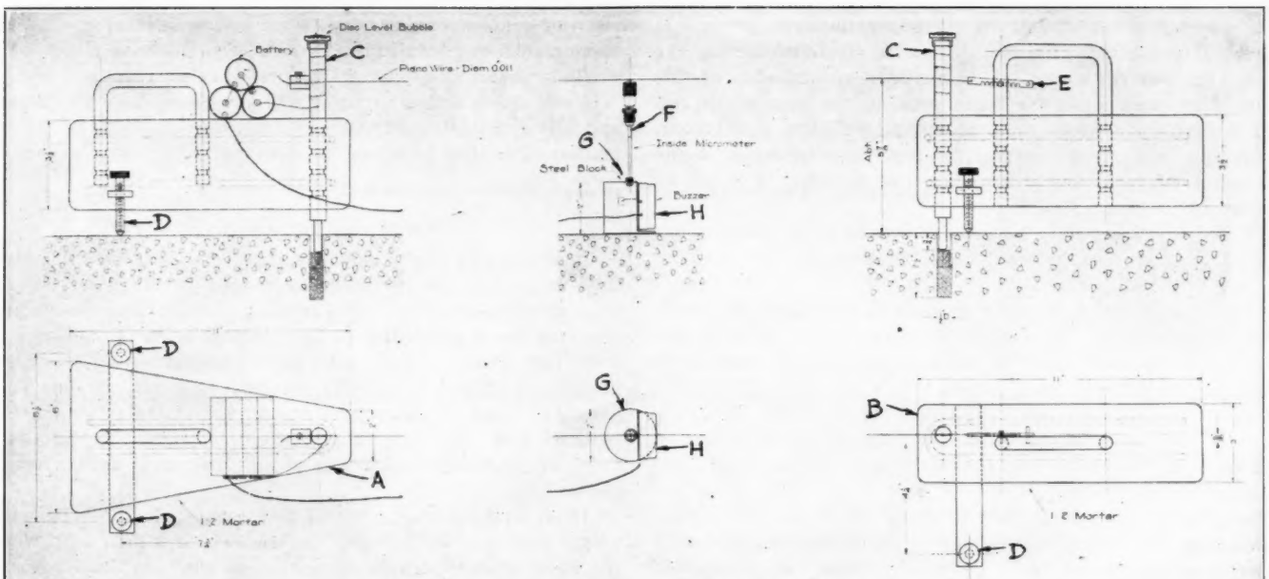
The last photograph shows the completed roadway.

The reports from the road show that it is in excellent condition and that it carries the heavy traffic with very little marking, even with a temperature of 98 degrees in the shade. The edges of the pavement at the ends, where traffic comes onto it, have thinned out to less than ⅛ in. and are as tenacious and hold their places as well as the pavement in general with no tendency to break off or disintegrate.

Resistance of Concrete Roads to Wear

In a letter to the editor, P. St. J. Wilson, assistant director of the U. S. Office of Public Roads and Rural Engineering, gives an outline of the plans of his department for testing the ability to resist wear of the materials of which concrete roads are built, and of the finished road, from which the following is prepared:

"For use in concrete road construction it seems to me, in



U.S.OFFICE OF PUBLIC ROADS.

INSTRUMENT FOR MEASURING WEAR OF ROADS.

view of the fact that many gravels differ in their resistance to wear, some sort of test should be included in this specification, governing the wear resisting qualities of the gravel. At the present time this office is developing an abrasion test for gravel concrete aggregate, and the method at present pursued is as follows:

"Five hundred grams each of material passing 1½-inch and retained on 1¼-inch, passing 1¼-inch and retained on 1-inch, passing 1-inch and retained on ¾-inch, passing ¾-inch and retained on ½-inch, and passing ½-inch and retained on ¼-inch, making a total of 2,500 grams, are run in a Deval abrasion machine, together with twenty 1¼-inch steel balls, for 5,000 revolutions. Material passing 1/16-inch is screened out and the residue washed and dried, rescreened as above, and each increment weighed. Pieces retained on each sieve are counted before and after, and the percentage of loss of material under ¼-inch, ⅛-inch and 1/16-inch is obtained. This test seems to be very promising and should aid in selecting a proper gravel for use in gravel concrete roads.

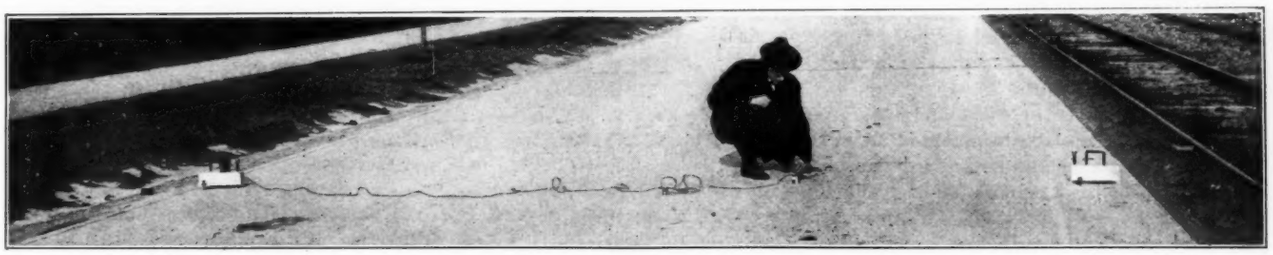
"Relative to abrasion tests on finished concrete, let me say that it is our purpose to make a number of wear measurements on concrete roads already constructed, where the traffic conditions are known. Tests will also be made on the aggregate composing the concrete. It is not believed that this will be of any benefit in permitting of the development of a specification for any particular kind of material, but will rather furnish a comparison of the behavior of the different materials in service. I am enclosing herewith a drawing of the apparatus and a photograph of it in use."

The following description of the drawing will show the construction and method of operation of the apparatus:

Pieces A and B are made of cement mortar and have embedded in them steel rods, C, drilled with holes slightly inclined with the horizontal. A fine piano wire about 0.01 of an inch in diameter is passed thru these holes and is stretched across the road from block A to block B. The tops of these rods are each provided with a disk-level bubble, so that when placed in position in the road the rods may be adjusted to a vertical position. Block A, which is heavier than block B, is provided with two adjusting screws, D, for adjusting rod C to the vertical. Block B rests on two points only, one the lower end of rod C and the other the end of adjusting screw D. Constant tension is produced in the wire by the weight of block B, which is pivoted about the bottom of rod C and is adjusted to a horizontal position by means of rack E, provided at the end of the wire. As the weight of block B is constant, the tension in the wire, and consequently the amount of sag for like spans, must remain the same. A very definite and fixed datum is thus provided, which should remain constant from year to year and which is very easily established by merely placing the end blocks of the apparatus in their proper position on the road.

The bottoms of rods C are spherical in shape; and when in use on concrete roads, they rest on the flat tops of bronze plugs cemented in the road surface. These plugs are ½ inch in diameter and are 1¾ inches long. They are set ¾ inch below the surface, and their tops are protected by means of a brass pipe plugged with a bituminous-sand mixture during the long intervals between readings.

In obtaining the wear measurements a chalk line is first snapped across the road between the bronze plugs, and the points at which it is purposed to take readings are marked on this line. At these points a steel block, G, 2 inches in diameter, is placed, in order to avoid measuring the small local inequalities in the road surface. In the top of this block a flat-bottomed cylindrical recess is made, and an ordinary in-



side micrometer is held in the recess, while its upper end is adjusted to contact with the steel wire stretched across the road. An electric buzzer, H, is mounted on the side of this block, and when contact is made between the micrometer and the wire an electric circuit is completed thru the buzzer. With this instrument readings for wear may be taken to the nearest 0.001 inch, altho this degree of accuracy will not be necessary.

Holes in the road in which the bronze plugs are set are drilled by means of a special hand-operated drill press carrying a star drill.

In the photograph of the apparatus in operation, the method of mounting the apparatus in the road and its manipulation are plainly shown. On the right is the heavier end block carrying the batteries, and on the left is the lighter block the weight of which supplies constant tension to the fine steel wire, extending between the blocks. The cord extending on the road surface from the heavier block to the small steel block carrying the micrometer is one of the leads from the battery to the electric buzzer. Placing the buzzer in this position near the operator obviously is advantageous, especially when the instrument is to be used amidst the distracting noises of traffic. The end blocks are set as near to the sides of the road as practicable, in order to permit measurements being taken across almost the entire width of the road. Should longitudinal cracks develop thru the sections measured, the readings so taken will be rendered useless; and in order to eliminate this difficulty, sufficient plugs must be set to permit obtaining readings at uncracked sections.

Wear measurements of this kind taken of the actual road surface should prove of great future value if the traffic conditions and the physical characteristics of the concrete materials likewise are known, and should help to decide present moot questions regarding concrete roads and road materials. Not only may concrete surfaces be measured for wear in this manner, but the wear of vertical movement of other kinds of road surfaces may likewise be determined by the use of this instrument.

The Value of Concrete for Roads

The Iowa State Highway Commission has published its first technical report, prepared in co-operation with the Good Roads Section of the Engineering Experimental Station at Iowa State College. It is entitled "An Investigation of Concrete Roadways," and its authors are T. R. Agg and C. B. McCullough. It is intended to supply the information concerning road surfaces, so far as concrete is concerned, which is asked for constantly by city and county officials and others. The city of Des Moines, in particular, has aided in the investigation that it might have the results as soon as possible for its own use.

The earlier chapters are studies of the failures in concrete streets in the city of Des Moines, showing the influence of classified factors producing the defective pavements, eleven classes of defects being attributed to inadequate specifications, fifteen to lax inspection and two to incorrect design. The lack of maintenance is also shown in its effect on condition of pavements.

Recommendations relative to specifications and inspections are given in one chapter, which goes into detail as to subgrade, methods of mixing and laying materials, joints, reinforcements, cement, fine, coarse and mixed aggregates and water.

The methods of making field and laboratory examinations and their results are given in much detail, with full reports of the data obtained from the individual streets examined.

Laboratory tests of concrete pavement samples are also fully discussed.

The last chapter, in an appendix, presents a theory of the wear of concrete roadways in first and second stages, transverse cracks and longitudinal cracks, and the book closes with a tabular analysis of current concrete paving practice.

Many of the matters treated will be discussed in detail later and communications on the subject are invited from our readers after they have had an opportunity to study the report.

National Aid for Good Roads

Congress has finally passed a good roads law, which is perhaps as good a law as could be expected at this time. It sets aside $10,000,000 to construct roads in the national forests and provides for distributing to the states $75,000,000, beginning with $5,000,000 the first year and increasing $5,000,000 each year until $25,000 is reached in the fifth year. Of this sum one-third is to be distributed among the states in proportion to their area, one-third in proportion to population, and one-third in proportion to mileage of star and rural delivery mail routes.

It is intended that none of this money shall be expended except thru a state highway department, and then only when the state appropriates an equal sum, so that the United States Government will not pay more than half the cost of any road. However, in the few states not now having state highway departments, smaller subdivisions of the state can obtain shares of the money if they act before the legislature meets. After the state has had such an opportunity to establish a State Highway Department, and has failed to do so, it cannot receive any part of the appropriation.

The Department of Agriculture must approve of the locations and specifications on which the roads are to be built and of the completed roads, before the government payments can be made.

These provisions will doubtless cause highway departments to be established in the few states without them, and also the appropriation of state funds for road construction in the larger number of states which have not yet made any such appropriations.

There have been some of the usual objections to national appropriations on the ground that road construction is a local problem. It is quite as local as the tariff problem, but scarcely more so under modern conditions of intercommunication. This argument might be good with the committee of a certain legislature, who did not need any one from the state or national capitals to tell them how to build roads; they knew what kind they wanted and how they should be made. Most of the committee belonged also to that portion of the community which emphasizes states' rights. But apparently most of the population approves of the national appropriations, provided they are expended on thru routes between states and not upon purely local mail routes, with little or no other travel.

Good Roads Notes

In 1905 there were 48,000 motor cars in the United States; in 1915 there were 2,445,664, an increase of 5,000 per cent. In 1905 less than three-tenths of 1 per cent of the money spent on account of building rural roads and bridges was derived from motor vehicle traffic; in 1915 nearly 7 per cent was derived from this source.

The help that a state highway department can give to local road officials in saving the taxpayers' money embraces many things which are not often anticipated. For instance, the Montana Highway Commission compiled a schedule of the prices paid for road material in the counties of that state and found a variation of 100 per cent in the cost of culvert pipe to the different counties. The attention of the local authorities was called to this variation, and as a result the prices thruout the state have become more uniform and the former very high prices ruling in a few counties have been reduced.

MISCELLANEOUS

The March of Events

August 29-31, at Johnstown, Pa. League of Cities of Third Class in Pennsylvania. F. H. Gates, secretary, Wilkes-Barre, Pa.

September 4-8, at Lexington, Ky. Southern Appalachian Good-Roads Association. Joseph Hyde Pratt, secretary, Chapel Hill, N. C.

September 13-15, at Tacoma, Wash. Washington State Association of County Commissioners. J. C. Hansen, secretary, Port Angeles, Wash.

September 14, a joint session will be had of the State Associations of County Commissioners, County Engineers and City Engineers.

October 2-6, at Grand Rapids, Mich. Playground and Recreation Association of America. H. S. Braucher, secretary, 1 Madison avenue, New York.

October 9-13, at Robert Treat Hotel, Newark, N. J. American Society of Municipal Improvements. Charles Carroll Brown, secretary, 702 Wulsin Building, Indianapolis, Ind.

October 17-20, at Chicago, Ill. American Gas Institute. Geo. G. Ramsdell, secretary, 29 West Twenty-ninth street, New York.

December 6, at New York. Society of Gas Lighting. Geo. G. Ramsdell, secretary, 29 West Thirty-ninth street, New York.

December 6-8, at Washington, D. C. National Rivers and Harbors Congress. S. A. Thompson, secretary, 824 Colorado Building, Washington, D. C.

December 5-8, at New York. American Society of Mechanical Engineers. Calvin W. Rice, 29 West Thirty-ninth street, New York.

December 26-31, at New York. American Association for the Advancement of Science. L. O. Howard, Smithsonian Institution, Washington, D. C.

January 20, 1917, at Kansas City, Mo. Western Paving Brick Manufacturers' Association. G. W. Thurston, secretary, 416 Dwight Building, Kansas City, Mo.

January 23-25, at New York. American Wood Preservers' Association. F. J. Angier, secretary, B. & O. Mt. Royal Sta., Baltimore, Md.

Civil Service Examinations

The United States Civil Service Commission will hold examinations at the usual places as follows:

August 8: Senior highway engineer in the Office of Public Roads and Rural Engineering, Department of Agriculture, at $2,200 to $4,000.

August 23, 24: Laboratory assistant in the Bureau of Standards, Department of Commerce, at $900 to $1,200.

Publications Received

The proceedings of the Second National Conference on Concrete Road Building in February have been received from the office of the secretary, J. P. Beck, 111 West Washington street, Chicago, Ill. The price is $1.

"Markets for Machinery and Machine Tools in Argentina" is the title of a 63-page report by Special Agent J. A. Massel, published as No. 116 of the Special Agents' Series of the U. S. Bureau of Foreign and Domestic Commerce. The price is 20 cents.

Report for 1915 of City Comptroller of St. Paul, Minn. W. C. Handy, comptroller.

The March bulletin of the New York State College of Forestry, Syracuse, N. Y., contains "Suggestions for Proper Procedure in Systematic Street Tree Planting for Towns and Cities of New York," by Henry R. Francis, assistant professor of landscape extension.

Water Purification Plants and Their Operation, by Milton F. Stein, assistant engineer of design, Cleveland filtration plant. A manual primarily for operators of water purification plants and also of interest to water works chemists and engineers. Cloth, 247 pp., $2.50. John Wiley & Sons, New York.

Forestry in Relation to City Building, by T. P. Lukens. Bulletin of Throop College of Technology, Pasadena, Cal.

The Model T Ford Car, Its Construction, Operation and Repair, by Victor W. Page. Cloth, 300 pp., $1. Also the Ford Trouble Chart. 25 cents. The Norman W. Henley Publishing Company, New York.

Municipal Accounting, by Dewitt C. Eggleston, M. E., C. P. A., Fellow of American Association of Public Accountants. Half leather, 456 pp., $4. Ronald Accounting Series, the Ronald Press Company, 20 Vesey street, New York.

Conservation of Water, by Walter McCulloh. Yale University Press, New Haven, Conn.

Conservation of Water by Storage, by Prof. George F. Swain, Harvard University. Yale University Press, New Haven, Conn.

Annual report of the city engineer of Cambridge, Mass. L. M. Hastings, city engineer.

Report of Water Department of Atlantic City, N. J., for 1915. L. Van Gilder, engineer and superintendent.

Design and Construction of the Massachusetts Institute of Technology Buildings, by Sanford E. Thompson, 141 Milk street, Boston, Mass. Paper, 21 pp.

Tests of Three Large-Sized Reinforced Concrete Slabs Under Concentrated Loading, by A. T. Goldbeck and E. B. Smith, reprinted from the Journal of Agricultural Research of the U. S. Department of Agriculture; also, A New Penetration Needle for Use in Testing Bituminous Materials, by Charles S. Reeve and Fred P. Pritchard.

Annual Report of Water Commissioner of Somerville, Mass., for 1915. Frank E. Merrill, water commissioner.

Railways as a Part of a System of National Defense. An

address by W. L. Park, vice president Illinois Central Railroad, before the International Association of Railway Special Agents and Police, at New Orleans, La., May 25, 1916.

The report of the County Highway Commission of Milwaukee county for 1915, which has just been issued, and in which there is much valuable information for those who are considering concrete roads. Mr. H. J. Kuelling, commissioner of Milwaukee county, has been responsible for a great increase in concrete roads in Milwaukee county during the past two years. Maintenance figures on concrete taken from Mr. Kuelling's report furnish more corroboration of experiences in maintaining well-built concrete pavement. The average cost per mile of maintaining the concrete was $35.01, equal to a square yard cost of .0034 cent. These figures are deduced from maintenance work involving 46.47 miles of Milwaukee concrete pavement.

Report of the operations of the Engineer Department of the District of Columbia for year ending June 30, 1915. Major Charles W. Kutz, engineer commissioner, Washington, D. C.

The National Board of Fire Underwriters, New York, has issued a proposed standard schedule for grading cities and towns of the United States as to fire prevention and extinguishing conditions and facilities which covers all the fire hazards, public and private, and the methods of offsetting them. If adopted it should eliminate much of the controversy over inequitable insurance rates by putting all cities on the same basis and putting it up to them to reduce their points of deficiency and thus elevate their class standing and lower their insurance rates.

Farmers' Bulletin No. 698 of the U. S. Department of Agriculture describes machinery of all sorts suitable for trenching for laying tile drains, from plows and scoops for small jobs, to wheel excavators, endless chain excafators and scraper excavators for jobs large enough for the use of greater or less power. The outfits range in price from $18 for a ditching plow to $6,000 for an elaborate power machine.

"A Handbook of Civic Improvement," by Professor Herman G. James, is published by the author at the University of Texas, Austin, Tex., in paper, at $1. Its 119 pages show what is to be expected of a city government in the line of civic sanitation, and what civic organizations can do to improve conditions. It has a brief bibliography of books on branches of the subject, which is not very complete, and series of questions for thoro surveys of communities upon each of the special subjects treated.

Suppression of Disease Carriers

The recent epidemic of poliomyelitis, or infantile paralysis, has again emphasized the necessity of getting rid of flies, as well as of other insects and small vermin.

The gradual elimination of the horse in the city will greatly reduce the fly nuisance, but meantime the greatest results can be obtained by applying to the removal of all refuse the same sanitary principle of promptness which is proposed for street sweepings in New York. Manure from stables, as well as from street sweepings, can be made practically fly-proof by treatment with chloride or hypo-chlorites, with little or no injury to its use as fertilizer, or in time of danger it can be incinerated with other waste and garbage, tho difficult to burn alone.

Sanitary closed cans for the deposit of garbage by householders and prompt collection of the cans or of the garbage in closed wagons, into which the cans can be emptied without opening them to the air, will do more than anything else a city department can do to eliminate not only this, but rats and other vermin, stray cats and dogs. All the city's refuse is subject to suspicion as to its sanitary condition, and similar care should be taken in its removal. If the incineration plan of disposing of all the city's refuse is used, by far the most sanitary method, all refuse and garbage can be collected together, the sanitary closed cans being used for everything, including ashes, except wood, old mattresses and other material too large for them.

The clean-up week in the spring, before fly time has begun, will do much to delay, at least, the development of the fly nuisance and is a valuable adjunct of the city's campaign for cleanliness. St. Louis has two clean-up weeks a year, and takes care of them without strain by making the extra collections in districts, stretching the week far enough to let all the districts in, each on its fixed days for the special collections.

Personal Notes

O. E. Carr is city manager of Niagara Falls, N. Y.

Frank Lotz is city engineer of Vader, Wash.

Ralph L. Rizer has been promoted to city engineer of Cumberland, Md., by the new city commission.

H. Moseley is city engineer of Dallas, Tex.

E. S. Hathaway is city engineer of Missoula, Mont.

Monty Hulse has been appointed city engineer of Sumner, Wash.

F. R. Marsh has been appointed city engineer of Great Falls for another two-year term.

Oscar D. Chrisman has been promoted to city engineer of Springfield, Mo.

Burger and Clarke is the title of the firm of patent attorneys at 2 Rector street, New York, which succeeds to the offices of Moore and Clarke and C. L. Burger.

J. C. Schmutz is city engineer of Pawnee City, Neb.

H. G. Roby has been appointed city manager of Alpena, Mich.

George Summers, recently chief engineer of the Citizens' Gas Company and now its consulting engineer, has opened offices at 904 Hume-Mansur building, Indianapolis, Ind., for practice as consulting engineer, appraiser of public utilities and efficiency expert.

George W. Tillson, M. Am. Soc. C. E.; Henry G. Shirley, M. Am. Soc. C. E., and Arthur H. Blanchard, M. Am. Soc. C. E., a commission of engineers, appointed by the Wilmington Chamber of Commerce, have recently submitted a report on the administration, construction and maintenance of highways which are under the jurisdiction of the Levy Court of New Castle county, Delaware.

The Dayton, O., office of the Morgan Engineering Co., of Memphis, Tenn., has been incorporated as The Dayton Morgan Engineering Co., with Arthur E. Morgan as president; L. L. Hidinger, vice president; M. H. Sayford, treasurer; S. B. Hutton and C. A. Bock, secretaries. Their specialties are flood control, drainage and reclamation engineering.

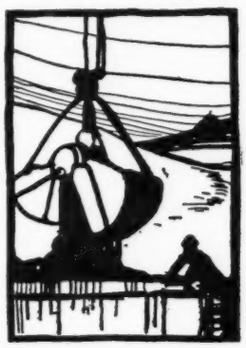
X. A. Kramer, of Magnolia, Miss., has been elected State Highway Engineer.

J. Ellingston has been promoted from city engineer to city manager of Sherman, Tex., vacancy left when Karl M. Mitchell, former city engineer and Mayor J. W. Hassel resigned.

Stephen L. Selden has resigned as vice president of J. G. White & Company, Inc., and has resumed the practice of the law. He has associated himself with Hardie B. Walmsley and Francis L. Kohlman, heretofore the firm of Walmsley & Kohlman, at No. 61 Broadway. The new firm will practice under the name and style of Selden, Walmsley & Kohlman, and will have its offices at No. 61 Broadway.

Wm. F. Cocke has been appointed State Road Commissioner of Florida.

Frank H. Zouck is the new chairman of the Maryland Road Commission.



MACHINERY AND SUPPLIES

The Dorchester Tunnel Under Boston Harbor

By George E. Wolcott, Boston, Mass.

A tunnel-driving project of considerable importance is under way at the present time in Boston, Mass. This is an extension of the subway system from the city proper to South Boston, under Fort Point Channel in Boston Harbor, a distance of approximately one mile under the water. The work is being done by P. McGovern & Company, contractors, who were the successful bidders, at about $2,500,000. The entering shaft is at a point near the South station of the New York, New Haven & Hartford railroad and the exit at West First street and Harrison avenues, South Boston.

The tunnel comprises two separate parallel tubes, each 24 feet in diameter. These are being driven by the caisson method from the South Boston end. One has advanced about 1,700 feet in blue clay, while the other, which has encountered hardpan and coarse gravel, has been driven about 1,000 feet. The rate of progress averages 15 feet per day in the clay, and 12 feet in the gravel. The work is, of course, continuous, the men working in eight-hour shifts.

As the tunnels are being driven wholly in compressed air, the most vital and important part of the power plant consists of the air compressors. These are three in number, all being class "WC" Sullivan tandem compound Corliss air compressors, with steam cylinders 16 and 28 inches, air cylinders 24 and 14½ inches in diameter, and a common stroke of 24 inches. Two of these machines are arranged for single stage compression, eachhaving a displacement of 2,058 cubic feet free air per minute, at a normal speed of 120 r.p.m. and are suitable for a maximum pressure of 30 pounds to the square inch. The third machine, while of the same dimensions, compresses air in two stages against a maximum pressure of 120 pounds, and has a displacement of 1,500 cubic feet free air per minute at 120 r.p.m. A fact worthy of note in this connection and applying with particular force to a plant of this kind, where both high and low pressure air is being used or required, is the case with which this tandem type of Sullivan air compressor can be converted from compound or two-stage to single stage and vice versa without any change necessary other than the removal or attaching of the inter-cooler and re-arrangement of inlet and discharging piping. These compressors also secure the highest possible steam economy, due to the fact that both high and low pressure steam cylinders are equipped with full Corliss valve gear, the point of cut-off being automatically varied to operate the compressor in the most economical manner by means of a special speed and pressure regulator, which is under the influence of the receiver pressure.

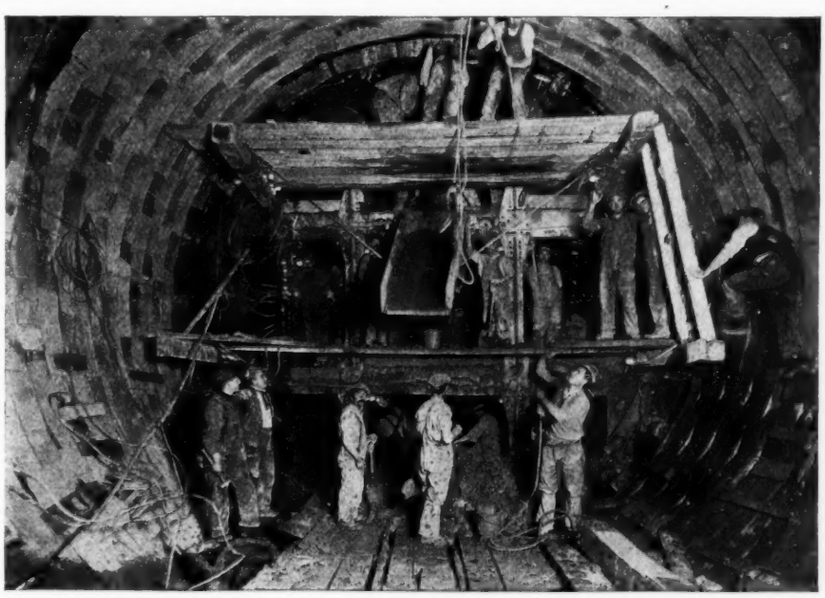
The boiler plant comprises four 150-h.p. Hodge horizontal return tubular boilers. The steam pressure is 150 pounds and a large condenser of the jet type is used. Large after-coolers are attached to the discharge pipes of both of the low pressure compressors, in order to reduce the temperature and humidity of the air in which the men have to work.

The splendid performance and economy already secured by the above plant as a whole is a source of much satisfaction to the owners, altho as yet it is operating below its full capacity. It is anticipated that even better results will be secured when the full power of the equipment is required as the work progresses.

Up to the present no rock whatever has been encountered, nor is any anticipated, aside from boulders, as the formation or deposit under the greater part of Boston Harbor, as well as under the eastern section of the city proper, thru which the existing subways have been driven, consists chiefly of blue clay with very little, if any, rock. At greater depths, under the clay, soundings indicate a slate formation, but this is not likely to be reached in the driving of the present tunnel.

The air pressure required in the shield thus far has not ex-

HEADING *in the Dorchester tunnel, showing the shield, hydraulic apparatus, and lining forms.*



ceeded 21 pounds to the square inch, altho it is expected that it will be necessary to increase this to 25 or 27 pounds when maximum depth under the harbor is reached at approximately 60 feet below the surface of low tide.

The two caissons or shields were furnished by the Boston Bridge Works and have cutting edges 26 feet in diameter. Each is forced ahead by twenty-four hydraulic jacks having a possible maximum water pressure of 100 tons behind each jack. They are thus capable of exerting a combined force of 2,400 tons if necessary to advance the caisson.

The progress thus far made in the driving of the tunnel has been somewhat more rapid than anticipated and it is expected that the work will be completed about October 1, 1916.

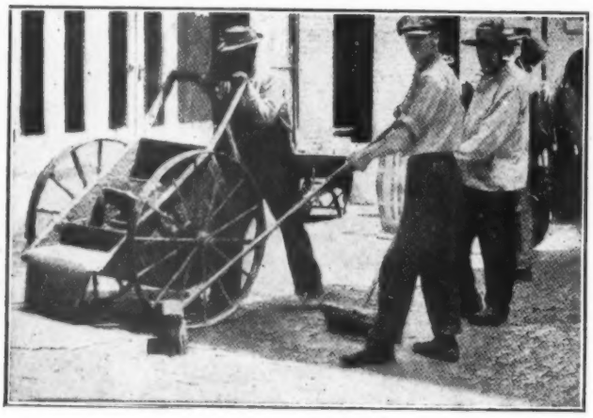
Atlantic Pumping Engines for Sewer and Conduit Repair Work

One valuable application of the Atlantic pumping engine, sold by Harold L. Bond Co., 383-391 Atlantic Ave., Boston, Mass., is to pumping water from manholes in sewers or conduits and then supplying air to the men making repairs therein. The plants are built for continuous operation with engine set in center of the hand truck, diaphragm pump at one end and blower at the other. The pump capacity is 2,500 to 4,000 gallons an hour according to speed at which pump is operated. They require little attention to keep them supplied with fuel and in condition for continuous operation. The engine cylinder is 4-bore, 4-stroke, generating 2 h. p. The pump is the No. 3 Atlantic shear-pin-beam diaphragm and the blower is No. 4, with belt coupled up ready to operate. Suction and discharge hose, couplings, valves, strainers and diaphragms are supplied to suit the individual needs of the purchaser.

The Jaeger Grout Cart

We are illustrating the Jaeger grout cart as used by prominent contractors in brick paving construction.

This outfit is equipped with paddles which keep the grout in constant state of agitation until finally deposited upon the pavement. The grout is first thoroly mixed in a moderate sized concrete mixer and is then deposited in the grout outfit, which is wheeled to the spot to be grouted. The mixer is placed with material at intersection or side of road or street. After the grout is mixed the entire batch is discharged from the mixer into one of the grout carts which is pushed by one man to the exact spot desired. Paddles inside revolve as the cart moves along, keeping the well-mixed grout assorted and preventing the sand from settling. When the proper place is reached, the cart is tipped and discharged and partly spreads the grout ready for the broomers to squeegee or finish. It is claimed that this method not only improves the quality of the grouting in every way but reduces the cost of labor to one-third of the hand method, as well as causing the grouting operation to be done in considerably less time than by the old puddling tub. This type of cart is made by the Jaeger Machine Co., Columbus, O.

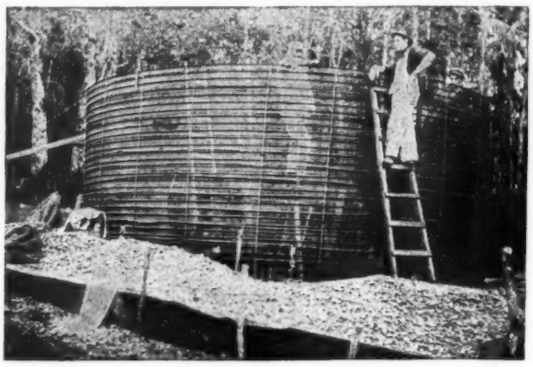


25,000-Gallon Concrete Reservoir

By J. A. Currey, Portland, Ore.

The new reservoir for the city of Monroe, Ore., is shown in the course of construction in the accompanying illustration. The view shows the Hy-Rib reinforcement in place before any concrete has been applied.

To complete the reservoir all that is necessary is to plaster the cement mortar on the reinforcement. No wood forms whatever are necessary in constructing the walls. The thin concrete shell is made up entirely of plaster coats of cement



mortar. The thoro reinforcement prevents any cracking under the strains of water pressure. This new reservoir has a capacity of 25,000 gallons, and an idea of its size is given by comparison with the men standing beside it. The reservoir is used in connection with the water system of the city of Monroe, which is a center of a large farming district in Oregon. The reservoir has proven highly satisfactory, and Mr. Francis has expressed himself as highly pleased with the results.

The reservoir was constructed by W. D. Straisser, Portland, Ore., under the direction of Mr. Charles Francis, chairman of the water board. Hy-Rib reinforcement was furnished by the Trussed Concrete Steel Company.

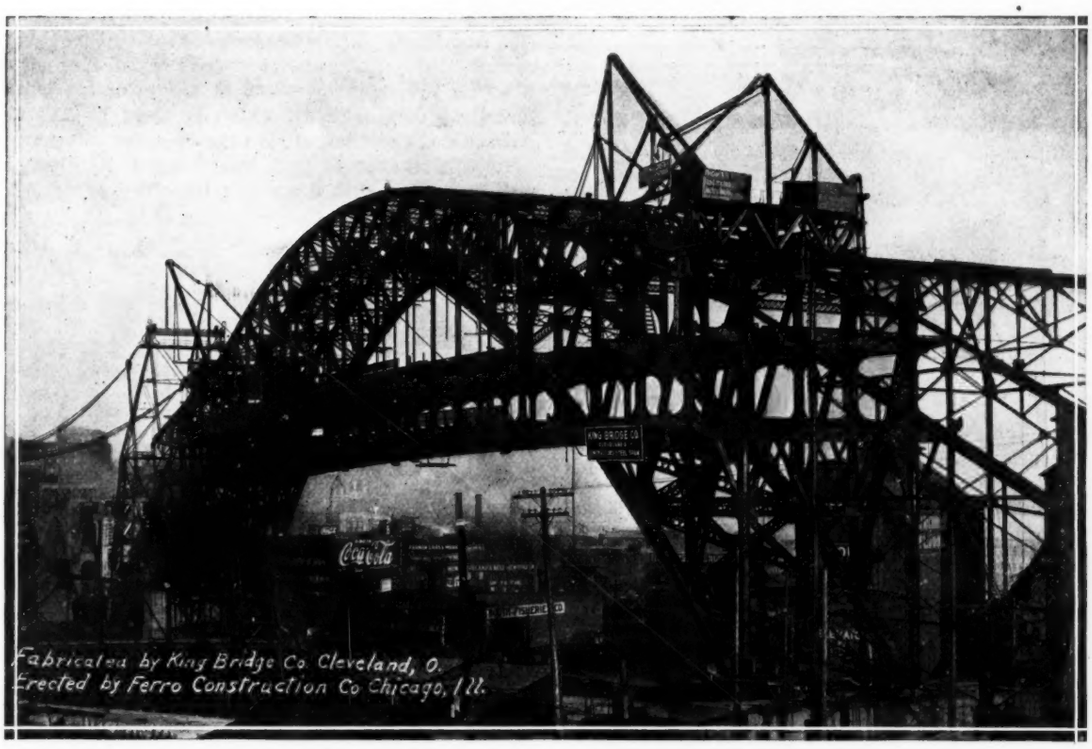
Detroit-Superior Bridge Construction

The recently completed 591-foot 3-hinged arch span of the Detroit-Superior high level bridge at Cleveland is said to rank third in span length in this country, being exceeded only by Hell Gate arch and Niagara arch.

Work on the east end of this arch was begun July 25, 1915, and on the west end August 26. The closure was made October 8. The actual working time on the west half was 32 days of 8 hours each, during which time about 1,250 tons of steel were placed. So accurate was the design and construction of the two halves of this arch that they lined up within a small fraction of an inch.

The equipment used for handling the steel put in this structure consisted of four 25-ton stiff-leg derricks, electrically operated, two being on each side. The material was hoisted from scows in the river.

The steel for this space was fabricated by the King Bridge Co., of Cleveland, and it was erected by the Ferro Construction Co., of Chicago, of which concern F. C. Fisher is president and F. F. Buck, superintendent of construction. The concrete arch approach work for the structure was done by the Hunkin-



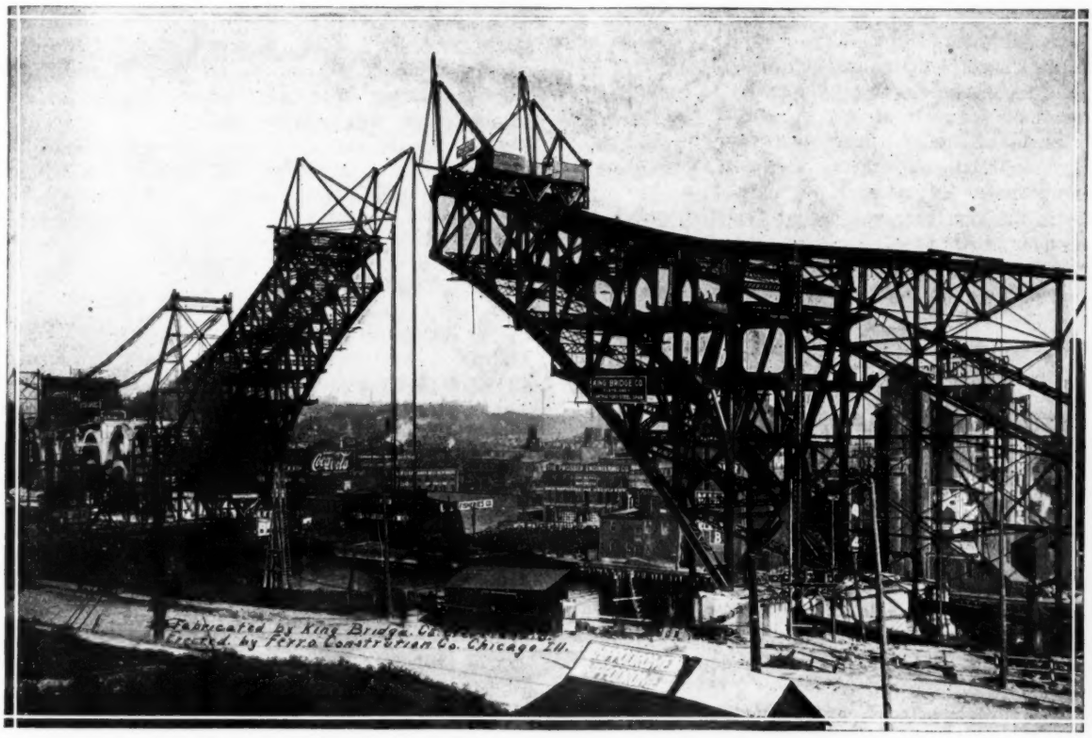
AFTER THE ARCH WAS CLOSED THE DERRICKS WERE USED TO ERECT THE DOUBLE-DECK FLOOR STEEL, BEGINNING AT THE CENTER AND WORKING OUT.

Conkey Construction Co., and this part of the work was described in MUNICIPAL ENGINEERING for August, 1915.

This bridge complete has a total length of 2,880 feet. It spans the Cuyahoga river and the wide valley adjacent to it, and connects Detroit avenue on the West Side with Superior avenue on the East Side. Two decks are provided, the upper deck to be used for highway traffic and the lower for street railway traffic. The upper deck is to have a 44-foot, 9 inch roadway and two 12-foot sidewalks, while the lower deck will carry six street railway tracks.

The two illustrations herewith are shown thru the courtesy of the A. Leschen & Sons Rope Co., St. Louis, Mo.

A VIEW OF BOTH SIDES OF THE ARCH. THIS ILLUSTRATION WAS MADE FROM A PHOTOGRAPH TAKEN SEPTEMBER 29. THE ARCH WAS CLOSED OCTOBER 8.



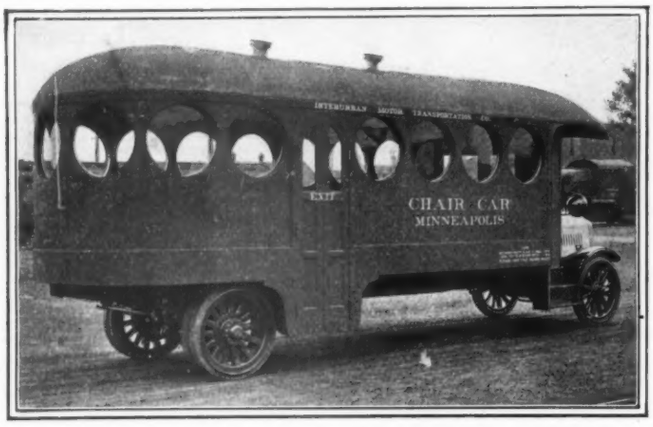
New Motor Truck Chair Car

The Interurban Motor Transportation Co., is operating McKeen highway motor coaches, between Minneapolis and St. Paul, Minn., with great success.

This type of motor chair-car introduces a new epoch in city, rural and interurban passenger transportation facilities. It discards the antiquated details of vehicular construction and incorporates the new and up-to-date designs of the McKeen railway gasoline motor car. It removes the universal criticism of the common bus—the discomfort due to unevenness of the road surface, all shocks, jars, etc., being entirely eliminated by its especially designed, patented, new, air-cushioned, steel spring, individual seat.

Its owners state that it is not an omnibus, nor a street car, nor a jitney, nor an electric car. It runs on paved streets.

The individual chairs with which this highway coach is equipped create a sensational advent in public service utilities. It is a new (patent applied for) pneumatic shock-absorbing cushioned seat, the remarkable elasticity and resiliency of which are obtained by four air cushions differentiated on each other and operating in conjunction with a 2-foot spiral steel spring.



MOTOR TRUCK CHAIR CAR. SEVERAL STEPS IN ADVANCE OF THE JITNEY BUS.

Adequate heating facilities are obtained from the waste product of the truck engine, there being twice the necessary heat units available for maintaining proper temperature of the car interior in the coldest of winter weather. The expense of installing and operating separate equipment for heating is therefore eliminated.

Entrance to the car is gained thru two-leaf, paneled, outward folding door beside the driver's position, the prepayment fare collection being under his supervision. Exit is thru double-leaf, paneled, outward folding doors in the side near the rear.

Passengers enter the car at the curb, thereby avoiding the congestions in street traffic. The entrance being only 15 inches from the ground makes the initial step from the curb approximately 7 inches.

This motor chair-car, as described, is designed and built by the McKeen Motor Car Co., Omaha, Neb.

The Burch Stone Unloader

The Burch stone unloader, as illustrated, requires that a small pit be dug under the track at the unloading point. This pit, next to the elevator, should be approximately 30 inches deep, about 32 inches wide and 20 inches deep at opposite side of track.

The stone is dropped from cars upon the platform, the feed doors of which can be opened one at a time and regulate the feed to the belt. The stone is conveyed to wagon by a continuous belt which runs at a speed of 225 feet per minute, delivering the stone to wagon at a rate of one cubic yard per minute. This machine, which is made by The Burch Plow Works Co., Crestline, O., is capable of handling any size stone that will be used on road improvement, it being necessary to regulate the width of opening in feed door according to size of stone.

The belt is a regular coveyor belt, is 16 inches wide, 4-ply, ⅛-inch rubber top covered and made especially to insure durability. The machine is so constructed that the elevator can be set at an angle of 26 degrees and with ground, where wagon sets, level with track, end of elevator will be 7½ feet from ground. Machine is guaranteed to carry stone at an elevation of 29 degrees, so it can be raised much higher than 7½ feet if necessary.

A clutch is provided at end of elevator within reach from wagon and when wagon is driven under it the driver simply throws in clutch, fills his wagon, then throws clutch out, and machine is waiting on next wagon, the engine running continuously. It will thus be seen that belt is always loaded to end of elevator ready to throw stone on wagon the moment clutch is thrown in, thus avoiding any delay in waiting for stone to be carried from car to end of elevator before starting to load.

Ford Pulls Ore Cars.

We are indebted to "Popular Science Monthly" for the illustration showing a Ford automobile, which on fast reaching the end of its usefulness in a mine in Texas, was recently knocked apart, put together again on a short, heavy chassis, and mounted on railroad wheels for use on a narrow-gage track Altho the automobile has been driven more than 12,000 miles, it fell to its new task with a will and has been behaving admirably ever since.

The weight of the full load pulled by the improvised locomotive, consisting of three 2-ton ore-cars, is about 16,800 pounds. Dragging this weight between various points about the camp it travels on an average of 18 miles a day, consuming during that time about 4½ gallons of gasoline and 1 gallon of oil.

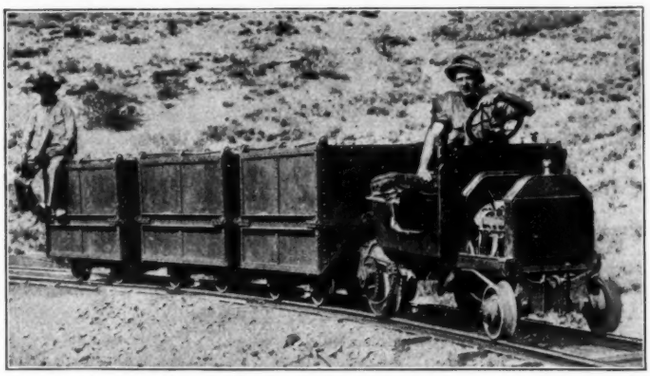
The cost of converting the touring car into a day laborer was $150.

Mr. E. M. Glenn, superintendent of the Presidio Mining Co., Shafter, Tex., in explanation of this conversion, writes:

"We haul three 2-ton, side dump ore cars, the total load being about 16,800 pounds, but with roller bearings it is possible that we could haul three more or a total of six, but in our case there is no necessity for doing so.

"About 1 per cent is the maximum grade we have, but there are many sharp curves. The track is 24-inch gage and laid with 20-pound rails. It is about 1 mile between terminals and at each terminal we have a turn-table.

"In converting the automobile to a motor, we shortened the driving shaft and moved the differential close to the transmission case, cut off the rear axle and used it for a jack-shaft, driving from it to the rear wheels with sprockets and chain. The gear reduction by the sprockets being 2:1, the small sprocket on the jack-shaft having 18 teeth and being 6 inches in diameter; the large sprocket on the rear wheels having 36 teeth and being 12 inches in diameter. The wheels are fitted with roller bearings and run on axles which are 1¾ inches in diameter. The channels of the frame were stiffened with heavy angle iron and a heavy iron strap made to take the place of the forward point of suspension, the strap passing under the engine and being fastened to the channels on either side. It was found that the machine does not work well using the built-in magneto of the flywheel and we put on a Bosch magneto, which gives reliable service and at least 30 per cent more power. In order to get traction it is necessary



A FORD AUTOMOBILE WHICH WAS CONVERTED INTO A MINE LOCOMOTIVE AT A COST OF ONE HUNDRED AND FIFTY DOLLARS. (COURTESY OF POPULAR SCIENCE MONTHLY.)

to place a heavy weight on the platform over the rear wheels.

"There were no other changes made than the above mentioned. The motor travels about 18 miles per day, consuming about 4½ gallons of gasoline and 1 gallon of lubricating oil. The total cost of making the changes, not including the Bosch magneto, was $150. We have two of these motors in service and one of them was driven as an automobile some 12,000 miles and has been pulling ore cars for two years. The cost of repairs is small.

"I do not know the maximum grade these machines could be used on, but I should think with a 3:1 gear reduction they might handle the load on a 2½ to 3 per cent grade."

Electric Tractor Shifts Cars

We are illustrating an electric tractor as used by the Pennsylvania Railroad Company to shift freight cars in the streets of Jersey City. On one of the wheels is a Kelly-Springfield sectional block tire which has seen twenty-two months' continual service.

It has been estimated that this tractor does the work of twenty mules. This outfit is equipped with two motors, each

GIANT ELECTRIC TRACTOR WHICH DOES THE WORK OF TWENTY MULES.

having a capacity of 20-h.p. It weighs 28,850, each wheel alone weighing a ton. The wheels are 60 inches in diameter. The truck straddles the railroad tracks, which, in city streets, are laid flush with the pavement. As showing the capacity of the tractor, it can start a draft of six loaded, 50-ton freight cars on the mountain grade of the Pennsylvania railroad—that part of the railroad from Altoona, Pa., to the crest of the Allegheny mountains.

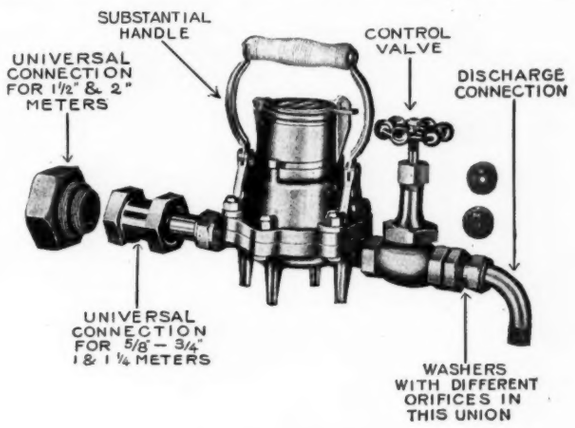
Portable Testing Water Meter

We are illustrating a portable testing meter, as devised by the Buffalo Meter Co., Buffalo, N. Y., which may be used in the meter repair shop or carried from place to place and the service meters tested without removing them from the pipes.

The test is made by connecting the testing meter in tandem with the service meter so that the same volume of water passes thru both, any error in the service meter being shown by the difference in registration of the two meters.

The testing meters are made in two sizes—the smaller, or ⅝-inch size, is provided with a connection for attaching to all meters of sizes from ⅝-inch to 2-inch, inclusive; the larger, or 1½-inch size, has a connection for attaching to 3-inch, 4-inch and 6-inch flanged meters. Each size consists of the meter with handles, connecting fittings, control valve, orifice washers and discharge connection. The dials indicate cubic feet or United States gallons at buyer's option.

The method of testing a meter in service is as follows: Shut off water at stop and waste cock; disconnect service meter on outlet side; attach the testing meter direct to the service meter by means of the universal fitting; open control


SUBSTANTIAL HANDLE
CONTROL VALVE
UNIVERSAL CONNECTION FOR 1½" & 2" METERS
DISCHARGE CONNECTION
UNIVERSAL CONNECTION FOR 5/8 – 3/4" 1 & 1¼ METERS
WASHERS WITH DIFFERENT ORIFICES IN THIS UNION

valve of testing meter; turn water on slowly at stop and waste cock, allowing several cubic feet to run so as to expel all air from the meters; then shut of water at testing meter control valve so as to stop the first hand of the service meter exactly at 0.

Next turn the frictional set back hand of the testing meter to O. The meters are now ready for the actual test, assuming that provision has been made for running off the discharged water thru a hose or otherwise.

If a test of any size meter from ⅝ to 2-inch is being made with the ⅝-inch testing meter, run thru either 10 cubic feet or 100 United States gallons of water (according to style of dial) and stop hand of service meter exactly at 0. Then see if the amount registered by the testing meter is different from the service meter; in a test of this quantity each of the numbered graduations on the circle of the testing meter represents 1 per cent from which the percentage of inaccuracy of the service meter (if any) may be immediately read.

Example: A service meter has registered 10 cubic feet and the testing meter 10.4 cubic feet. The service meter is therefore about 4 per cent slow.

If it is desired to test the service meter on smaller flows, disconnect the union at discharge end of testing meter, insert one of the orifice washers, and proceed with test same as before.

The method of testing with the 1½-inch testing meter is the same, tho it is often necessary to tap the pipe or change it some to connect the testing meter.

It is customary to adjust new meters to measure within 2 per cent of absolute accuracy. Old meters in service are not usually expected to measure quite as closely.

However, if they are found to be too far off, they may be adjusted by means of new change gears with more or less teeth. The change gears are just beneath the indicating mechanism.

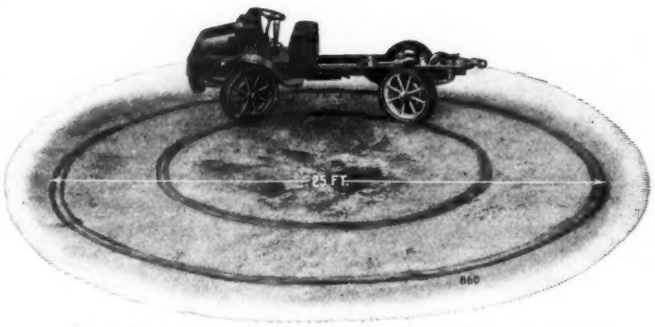
Walter Four-Wheel Drive Tractor

The Walter four-wheel drive tractor, as illustrated, which drives, steers and brakes on all four wheels, is quite extensively used in foreign military service. While it has not as yet been placed on the market for contracting work in this country, it nevertheless possesses obvious advantages, as the application of power to each of the four wheels makes each wheel a pulling unit, prevents skidding, and enables the tractor to climb over obstructions and negotiate hills, mountainous country, muddy and sandy roads, etc. This outfit is designed to carry a two-ton load and haul up to eight tons, on one or more trailers, depending upon the condition of the road and grades. A powerful four-cylinder, four-cycle, vertical engine, designed especially for tractor service, furnishes the power and operates at a normal crankshaft speed of 1,200 revolutions per minute.

This tractor possesses the added feature of being equipped with irreversible, positive drive differentials, of a special type, which give positive drive to all four wheels and eliminates the use of a separate differential lock. These differentials are of a new and distinct type, and are so designed that the entire motive power is applied to that particular wheel or wheels having traction, although one, two or even three of the wheels are on a slippery surface.

These irreversible, positive-drive differentials make it possible to drive this tractor even though the condition of the road offers traction to only one wheel, and on striking soft roads none of the momentum of the tractor is lost by the necessity of stopping to throw in a differential lock, as is required with the ordinary type of differential.

The steering gear is so designed that all four wheels can be turned to an angle of 30 degrees, which enables the tractor to turn (either forward or backward) within a circle of only 25



THE WALTER FOUR-WHEEL DRIVE TRACTOR MAKING COMPLETE TURN IN CIRCLE 25 FEET IN DIAMETER.

feet in diameter. The wheels are heat-treated open-hearth steel castings with hollow spokes and rims, provide maximum strength, and are mounted on oversized taper roller bearings. Both front and rear wheels are equipped with dual 1000x100 m.m. solid rubber tires.

A spring drawbar located at the extreme rear end of the frame takes up the starting and stopping strains and road shocks when hauling trailers.

A powerful winch, equipped with 100 feet of ⅝-inch cable and driven by a worm gear, is also provided, for extricating the tractor (either forward or backward) from soft ground, muddy and sandy places that offer no traction to the wheels, and for pulling up trailers for coupling, assisting in loading, etc.

The trailer hook, which is of ample strength, is mounted in the rear cross-member of the frame, and is provided with an automatic lock, which allows the instantaneous application of a ring or trailer drawbar to the hook and securely locks it in place in such a manner as to positively prevent accidental disengagement. The trailer hook is also provided with a large helical spring, so wound as to take up the road shocks and starting and stopping strains (when hauling trailers), thus insuring a smooth change of gears.

The powerful winch, equipped with 100 feet of ⅝-inch cable and driven by a worm gear, is located at the rear end of the tractor. The winch head is 13 inches in diameter and 18 inches long between its flanges, and may be disconnected from the worm gear to permit the unwinding of the rope or cable from the drum without operating any part of the driving mechanism. The winch worm gear is operated by a lever at the extreme right of the driver and is actuated by a shaft, driven and controlled from the transmission gear case.

New Trigonometric and Numerical Computer

To simplify and extend the use of the slide rule a new circular computer has been devised. It is shown in the illustration, and consists of two graduated dials rotating concentrically, with a running arm, and a transparent protecting cover.

This computer solves at one setting of dial three factors, including trigonometric and exponential terms. The answer appears at two different points of the dial, one proving the other.

The scales, beginning with the outermost, are:

1. Degrees, 0° to 360°; for measuring angles.
2. Radians, 0 to 2 Π (6.283); for circular measure.
3. A scale of equal parts, 0 to 1000, to read logarithms.
4. Scale N, for setting the first number and reading the answer.

The scales on the inner dial are:

5. Scale M, like scale N, but reversed, to set multipliers.
6. Scale D, like scale N, to set divisors.
7. Sines and cosecants, 6° to 90°; cosines and secants, 0° to 84°.

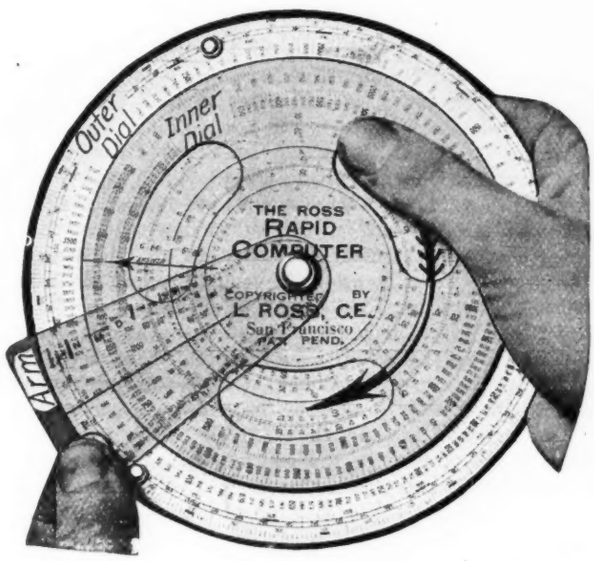
8. Sines and cosecants, tangents and cotangents, 37′ to 6°; cosines and secants, tangents and cotangents, 84° to 89° 23′.

9. Tangents and cotangents, 6° to 84°.

10. A scale of squares.

11. A scale of cubes.

With this arrangement of scales computations can be made with a minimum number of settings, because each movement of either the arm or dial performs an effective calculation, there are no blank movements as in multiplying 3x4x5 with the ordinary slide-rule; moreover, the answer never runs off the scale, and appears simultaneously on both dials, thus checking against both personal errors of misreading, and against any instrumental errors. The trigonometric scales are full and complete, obviating the necessity of taking com-



plements of angles or reciprocal functions. Equivalent ratios and reciprocals of numbers may be read at a glance; the operation for multiplication and division is identical.

The conventional method of graduations, which requires months to master, has been dropped entirely, and a simple system of 3 and 4-figure numbers adopted, so that anyone who can read a foot-rule can use the rapid computer directly. The length of scale is 21 inches in the 8-inch computer; so as to read numbers to three or four places, like: $24.67 \times 8.69 = 214.4$, or $24.67 \div 8.69 = 2.839$.

The instrument is made in two forms; one of weather and wear-proof celluloid; the other of bronzed metal discs, with engraved graduations, like a compass or transit, for office use. The computer has been invented by Louis Ross, civil engineer, of San Francisco, and is made by the Computer Mfg. Co., 25 California street, San Francisco.

Special Motor Car for Movie Men

Probably the first specially built motor car to be used in gathering moving pictures of actual warfare was built recently by The Thomas B. Jeffery Company, Kenosha, Wis., and delivered to the Selig-Tribune Company, of Chicago. It is now along the Mexican border and is taking daily trips into the

war-ridden republic, getting scenes for a news film released twice weekly.

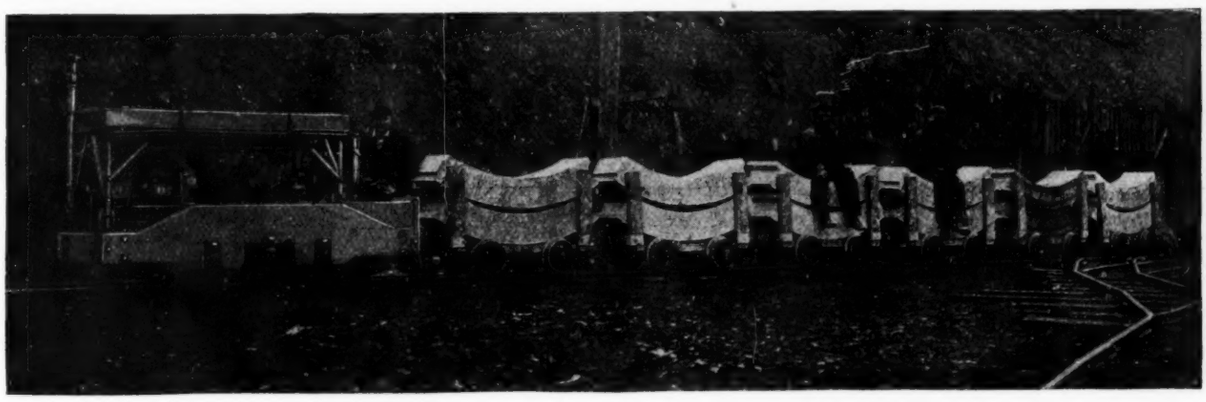
The body of this car was built on a standard Jeffery Four chassis. Mounted on the frame behind the driver's seat is a large square box, which is used both as a carryall and by the camera men. A sloping khaki top may be raised to protect the outfit from both sun and rain. The box is so constructed as to be able to carry a machine gun, in the event that one is necessary.

Two large tanks are suspended from the rear of the body box. One is for oil and water, having a capacity of 15 gallons of water and 8 gallons of oil. The larger tank carries 50 gallons of gasoline. The size of these tanks is rendered necessary by the long distances the outfit must travel over arid wastes.

Plymouth Gasoline Locomotive

We are illustrating a 2½-ton Plymouth gasoline locomotive as operated by the city of Cleveland, O., in the construction of the East Side water works tunnel. This engine, which is manufactured by the J. D. Fate Company, Plymouth, O., and as shown in the view, was used for the hauling of large cement blocks from the cement block plant to the opening and

PLYMOUTH LOCOMOTIVE AS USED BY CITY OF CLEVELAND, O., ON EAST SIDE WATER WORKS TUNNEL CONSTRUCTION.



part way in the tunnel, where the blocks are then picked up by a compressed-air locomotive, which operates in the tunnel and out to the work. At the present time this is about two miles out from shore.

The compressed-air locomotive is used in the tunnel in accordance with the state law of Ohio, which does not permit of a gasoline locomotive being used in a mine or tunnel.

This type of gasoline locomotive is also quite extensively used in road work.

The Largest Drag-Line Excavator

The P. & H. drag-line excavator, class 210, shown in the accompanying photograph, is the largest yet built. It has a revolving frame supporting a boom and internal combustion engine, an A-frame, a drag drum, a hoisting drum, a boom topping lift drum, a tubular water cooling radiator, an air compressor, a centrifugal water circulating pump, a gasoline tank suspended from beneath and a compressed air tank also suspended from beneath.

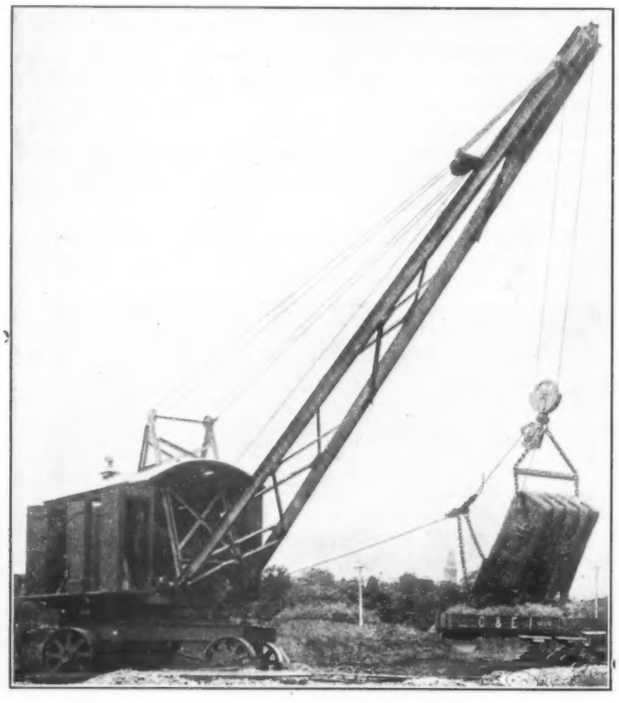
All machinery, including boom and A-frame, is sustained on two heavy girders. All the necessary clutches are provided for swinging upper frame and for propulsion. Drum band frictions are operated by compressed air rams. This upper frame rotates on the lower frame by rack and pinion and revolves on four 2-wheeled trucks, treading upon a 60-pound rail circle. Truck frame wheels and center castings are made of annealed steel.

The lower frame is of I-beam construction, designed for taking all the heavy strains that are imposed upon it.

The excavator is self-propelling either on broad-faced power-traction wheels or corduroy grips. The engine house consists of angle-iron framing incased in double beamed and matched yellow pine ceilings. The roof is of the same material and covered with heavy canvas. The whole is thoroly painted. Water circulation and force feed lubrication is entirely automatic.

Length of boom is 40 feet; capacity of bucket, 1 cubic yard; horsepower of engine, 70; rotating speed, 2½ revolutions per minute; diameter of turn table, 8 feet; traction wheels are cast steel, provided with three sets of spokes.

The four corduroy grips are driven from live axle by internal steel sprockets and chain from back axle. The front axle suspension is three point for traveling. The upper frame is rigidly held in position by jack nuts when working. The back, or driving, axle is a solid steel forging. The front axle is built up of 12-inch I-beams with stub ends for removing in case of wear.



All bearings are provided with the necessary grease or oil cups. All gears are of annealed cast steel. Spur gearing is cut from solid steel blanks.

The weight of the machine is 30 tons.

This machine can be equipped with either steam, internal combustion engine or electric power taken from outside sources or the current can be generated on the machine, if so desired. It is made by Pawling & Harnischfeger Co., of Milwaukee, Wis.

Trade Publications

A recent booklet on the Koehring mixer describes and illustrates its use on one of the contracts on New York's biggest job, the subway, as operated by the Rapid Transit Construction Company.

An excellent idea in showing results is that in a recent booklet of the Pioneer Asphalt Company, Lawrenceville, Ill., which uses inserted half-tones good enough to pass for the original photographs. They show the use of Pioneer asphalt of the proper grades in asphaltic concrete pavement, asphalt pavement, Topeka mix road, open type asphaltic concrete, penetration road and road resurfacing, thus showing at once the adaptability of this company's products and their success.

Brownhoist tram rail systems, trolleys and electric hoists are shown in catalog D, 1916, of the Brown Hoisting Machinery Company, of Cleveland, O.

The Diesel engine, in the central station service of the Northwest Light and Power Company, at Hutchinson, Minn., and its economy are shown in a recent handsomely illustrated circular of the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo.

Concrete edge protection is the subject of a circular of F. W. Stocker, Inc., engineers, 1031 Clinton street, Hoboken, N. J., which shows the flexibility and adaptability of the Stocker anchoring curb bars and corner protection bars for concrete corners in any situation.

"The Medusa White House" is the title of a handsome booklet showing the excellent results of the use of Medusa white cement in the construction of houses, for exterior surfaces, steps, railings, columns, cornices, door and window casings, decorative panels, pergolas, etc., in which the artistic effect is a consideration. It is issued by the Sandusky Portland Cement Company, Cleveland, O., and will be sent on request.

The "Service Manual" issued by the Service Motor Truck Company, Wabash, Ind., goes into detail as to the construction and operation of each part of the machine, so that it is in truth a manual of the truck for practical use.

The Sterling-Kindling motor squeegee street washer, a combination of the Kindling squeegee and the Sterling motor truck, is made by the Sterling Motor Truck Company, West Allis, Milwaukee, Wis., and is fully described in an illustrated circular issued by them.

The American Rolling Mill Co., Middletown, O., distribute several circulars containing articles from various periodicals on particular installations of Armco pure iron in corrugated culvert construction, for electrical and other purposes where a very pure iron is required.

The Sandusky Cement Co., Cleveland, Ohio, issues a folder on Dry Basements a Reality, which contains an unsolicited testimonial from H. T. Liebert, a prominent architect, of Wausau, Wis.

The American Blower Co., Detroit, Mich., have a book on washed air which they will send on request.